THE

ELECTRICAL REVIEW.

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THE

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1900

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NOW IN PREPARATION.

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THE ELECTRICAL OUTLOOK.

WITH the present issue of the ELECTRICAL REVIEW we are enabled to place in the hands of our readers a list showing, more or less clearly, the present position of the electric traction section of electrical development within the United Kingdom. The statistics and other information there published are as complete and accurate as circumstances have permitted us to make them. We have to express our thanks to the engineers and others having a controlling hand in these undertakings, for their readiness in lending us their valuable co-operation, and we hope that in future issues of this list the columns now of necessity left blank will be filled in with figures which will not only be interesting, but will at the same time show what splendid results it is possible to obtain by working tramways electrically. The figures showing cost per car-mile and ratio of expenses to receipts are, as everybody knows, not easily obtainable. Where they are accessible we have included them, but in a number of cases it will be observed that the accounts for a complete year are not yet made up, as the systems have not been long in operation. Next year, and in future years, we may hope that not only will there be at hand the working costs, &c., of tramway systems, but what will be even more important to some minds, viz, the figures showing the results attending the practical operation of municipal combined lighting and traction stations in full working.

It is, of course, understood that, above and beyond the systems which are now particularised, there are a host of towns in the country which have passed municipal electric tramway schemes; these are now being planned, and will shortly be in course of construction, but they have not reached that stage at which any particular details are available, or at any rate of especial value. The same remark also naturally applies to numerous schemes which are in the promotion, and even perhaps the construction, stage, in the hands of private companies.

We need hardly indulge here in fancy dreams of what the future has in store for the electrical engineering industry, and, in consequence, for electrical engineers personally. This was sufficiently marked out in Mr. Philip Dawson's interesting article in our last issue, the reading of which must have given young engineers a very rosy view of the land of promise, and made them feel glad that they were born.

That the promise of the future is very largely wrapped up in electric traction is again proved, if any further proof were necessary, by the very numerous and important applications which are now being made to Parliament and the Board of Trade for sanction. In another part of this issue, we have brought together, so far as is possible at the time of writing, a few general notes denoting something of the character and extent of the various schemes. The list is not complete, but a study of

it is interesting as conveying a general idea of some points which will be raised in connection with electrical legislation during the session. Tramway and light railway applications are very plentiful; more so, we imagine, than electric lighting schemes. Private enterprise claims a very large share of the lighting schemes, and this is only what might be anticipated now that the larger boroughs have their installations working. With the smaller districts we can think of nothing better than that where possible several of them should be under the control of one company, and supplied from the same generating station, unless municipalities can make equitable arrangements for furnishing current on a similar system. This latter is a source of profitable and convenient supply, to which a number of towns are directing their attention, as is evidenced by several of the applications referred to. The question will, doubtless, be controverted somewhat, particularly as the country is now pretty well studded with proposals brought forward by private companies, but the result will be favourable to municipalisation if Parliament adheres to its policy of municipal protection and favouritism.

The large electric power distribution schemes have increased in number, and the supply of electricity in bulk, with the compulsory purchase of land, laying mains through other districts, together with the question of private and municipal competition in electricity supply, are among the matters which will require serious consideration. The very important question of municipal trading will be re-introduced, for there are numerous clauses in which powers are sought for the manufacture, supply, &c., of electrical fittings and apparatus. For the best interests of the industry, we hope that the proposals will meet with a dismissal as summary as was given to some scores of such applications last session.

In electric railway traction we find, among others, the scheme of the Mersey Railway Company to adopt electrical working. This proposal has been on the cards for a long time now, and at the present moment the board has relegated it to the care of Sir W. H. Preece and Major Cardew as advisers. Although nothing may be immediately accomplished, we imagine that some practical scheme will not be long delayed. Then there is the "lightning express" railway scheme for Manchester and Liverpool.

The City of London Electric Lighting Company is promoting a Bill to provide for the new generating stations which its daily increasing business renders compulsory in the immediate future; and its prospective competitor, the Charing Cross Company, seeks various powers in connection with its proposed West Ham station, from which current will be supplied for its City business, when it gets to work.

These few remarks may serve to show that matters of surpassing interest are on the agenda for settlement. The experience of previous years inclines us to fear that a number of the applications may never get beyond the paper stage; but allowing for a good percentage of failures, the outlook indicates a continuation and even an accentuation of the prevailing activity in every branch of the electrical profession. Assuming the readiness and fitness of works to cope speedily with large contracts, and the absence of labour troubles, the next few years ought to be very satisfactory from every point of view

Physical Society Meeting.

The attendance on Friday was very small—altogether disproportionate to the value of the papers, and a sorry contrast to the numbers that attended the Dinner the previous week. Dr. C. H. Lees presented two papers, the second being the complement of the first (1) "On the Conductivities of Certain Heterogeneous Media for a Steady Flux having a Potential;" (2) "On the Thermal Conductivities of Mixtures and of their Constituents." In a few "brief but well-chosen words," he explained the results of what is really a hard piece of mathematical work, of wide application, and of practical importance. The papers were not read in full, but from the short account of them given by Dr. Lees we gather that they deal with the general case of conduction through a medium constituted of a mixture of definite proportions of substances whose individual conductivities are known. In the particular instance chosen by Dr. Lees, the problem is to determine the conductivity, for heat or for electricity, of a liquid mixture of two constituents present in fixed proportions. With a few exceptions, which must be disregarded, the conductivity may be taken to lie somewhere between the conductivities of the constituents. As the result of certain experiments, Dr. Lees finds that in a particular case if k is the conductivity of a mixture, whose constituents have conductivities k_1, k_2 in the proportion p_1, p_2 where $p_1 + p_2 = 1$, the equation $k = p_1 k_1 + p_2 k_2$ gives too low a result; and the equation

$$\frac{1}{k} = \frac{p_1}{k_1} + \frac{p_2}{k_2}$$

gives a result too high. This means that a mixture can neither be represented by alternate parallel layers of the two substances, nor by a chequer-board arrangement of conductors, passing from one potential face to the other. In other words, it is represented neither by a "series" nor by a "parallel" network. Dr. Lees next considers the case of conduction through a structure of small cubes, each set diagonally to the stream-lines, one half of each cube on one side of a diagonal, being of one substance, the second half of the cube being of the second substance. The integration for the conductivity in such a case is a very pretty problem, and leads to the equation $k = \sqrt{k_1 k_2}$, or more generally, $k = k_1^{p_1} k_2^{p_2}$; this agrees much more closely with the experimental results than do the other formulæ. As we have not yet had an opportunity of seeing the paper, we are not in a position to criticise the argument. It appears to us, however, that the case taken by Dr. Lees is again only an approximation, an approximation which might have been arrived at almost *a priori*. For since the arithmetic mean of two unequal positive quantities, their positive geometrical mean, and their harmonic mean, are always in descending order of magnitude, it is evident that when the arithmetic mean gives a result too low, and the harmonic mean a result too high, the geometric mean will be a closer approximation than either. The discussion elicited a point of interest to electricians, *i.e.*, that the formulæ were of direct application both as regards "capacity" and "dielectric resistance" to mixtures of two or more dielectrics. If $p_1 + p_2 + p_3 + \ldots = 1$, the most useful form of the equation is of course

$$\log. k = p_1 \log. k_1 + p_2 \log. k_2 + p_3 \log. k_3 + \ldots .$$

Train Electric Lighting.—A New York exchange says that the Atchinson, Topeka and Santa Fé Railway will be lighted by electricity generated from dynamos on the car axles, and the locomotive headlights will be supplied from the same source. Each car will have a separate plant, consisting of a dynamo and storage batteries, and the full train will have electrical equipment equal to over 4,900 C.P., exclusive of the locomotive headlight. These trains, it is said, will be the longest solid axle-light ones in the world, and will be the first to carry so large a lighting service derived exclusively from the car axles.

SOME NOTES ON ROTARY CONVERTERS, WITH SPECIAL REFERENCE TO THE EXTENSION PLANT OF THE CHICAGO EDISON COMPANY.

By A. C. EBORALL.

(*Continued from page* 830.)

Another disadvantage connected with the employment of this method of starting from the polyphase side is, that the machine is just as likely to synchronise at the wrong pole as not. As the direct current sides of each rotary have to be put in parallel, it follows that all machines must have a definite polarity, which must always remain the same. It is therefore necessary, when starting up in this manner, to have a pole-indicator on each direct current panel of the switchboard, and if this indicates that the machine has come up to synchronism at the wrong pole, the rotary will have to be re-started, and the direct current side left open until the polarity is right.

In order to reduce the starting currents taken by rotary converters when starting from the polyphase side, an auxiliary polyphase induction motor can be arranged to bring the main unit up to speed. This motor must have an output of about 7½ per cent. of that of the rotary, and is preferably mounted on a bracket with its armature built-up on an extension of the shaft of the rotary converter. The stator of this auxiliary motor must be wound to have fewer poles than there are on the rotary, in order that the latter may be brought somewhat above synchronous speed by the direct-coupled motor. The rotary would be started by connecting the motor to the low pressure polyphase bus bars, allowing it to bring the rotary above synchronous speed, then exciting the latter from its own direct current side, or from the direct current bus bars if other machines are running, which would cause the speed to drop somewhat, and which, if not sufficient, could be still further diminished by means of a friction brake on the shaft, or by loading the direct current side. The rotary converter would then have to be synchronised, and then switched in. This method of starting also requires the employment of pole indicators in case the sub-station had to be wholly shut down and re-started again, but is far better than the method described above, the principal objections to it being the increased first cost, and increased complication to an already complicated business.

It appears to the writer that in sub-stations in which two or more rotaries are at work, the best means of starting is to employ this method in conjunction with a small accumulator battery. One or more of the rotaries (but not all of them) would be provided with auxiliary induction motors, in order to start the sub-station plant initially, and the remaining rotaries would be started up from the direct current bus bars as they were required, the accumulators being charged from these bus bars at convenient times. The capacity of the battery would not need to be greater than 10 per cent. of the output of the largest rotary, at the outside, and the lighting and ventilating of the sub-station could be done from it if desired.

From the above remarks, it will be seen that if it is laid down that the converting plant shall be capable of starting from either side—an absolute necessity in nearly every case—this can only be attained when rotary converters are used, by the employment of complicated switch gear and experienced operators.

The next question to consider is that of parallel running, and it is one of the most important connected with the employment of rotary converters. Satisfactory parallel running of these machines depends almost entirely on the design of the generator engines, and to a much greater extent than is the case with ordinary alternators. It may be said at once, that if the engines are unsuitable for the purpose, there is bound to be trouble in the sub-stations, due to hunting of the converters, and to the consequent interchange of current between the different units. In order to minimise this hunting, it is standard practice to put "damping coils" (amortisseurs) on the field poles of the converters. These coils take the form of massive copper bands, either imbedded in the pole-pieces or else wound round them, and short-circuited individually, and their action is to damp down or kill the pulsations due to want of uniformity of the main driving power. The damping effect is caused by the magnetic field produced by the currents induced in the short-circuited coils by the pulsations of the field strength, and it may be remarked here that within limits these coils are very effectual, and are, in fact, an integral portion of the design of the rotary. But if the engines are unsuitable, satisfactory parallel running is impossible, even with the assistance of the damping coils.

In this connection, a suitable engine may be defined as one in which the angular velocity during one revolution does not vary more than ½ per cent. at constant load.

The parallel running of rotary converters is also affected by the amount of self-induction between the various units, by the pressure drop in the transmission lines, and by the adjustment of the field excitation, but only to a comparatively small extent.

Switchboards to control a number of rotary converter units working together in a sub-station are unavoidably of a very complicated nature, as a little consideration will show. In addition to the switch gear required by the two sides of each rotary, there must be provided switch gear for the transformers, synchronising apparatus, extra starting apparatus, and boosting or pressure regulating devices, and, as a consequence of this, the sub-station switchboards become very costly, and take up considerable space.

It is practically only with regard to the important points of efficiency and power-factor that the rotary converter scores over the motor-generator to any extent, and with regard to overload capacity. The efficiency of a rotary converter plant is certainly higher than that of a motor-generator plant by 4 to 5 per cent. This is, of course, owing to the higher efficiency of the stationary transformers compared with the asynchronous induction motors; the figure obtained at full load with large plants will be not less than 94 per cent. With regard to the power-factor, this will be approximately 100 per cent. at full load, because the excitation is so adjusted that the armature current neither lags nor leads, rotary converters behaving in this respect in exactly the same manner as synchronous motors. It may be said here that the high power factor of rotary converters is perhaps their greatest advantage—there being no idle current, copper is saved in the mains, alternator armatures, and transformers, and, moreover, excellent pressure regulation over the whole of the system is easily obtained.

The overload capacity of rotary converters is considerably greater than that of motor-generators. As the reactions of the synchronous polyphase motor approximately equalise those of the direct current generator, there is practically no sparking at any load with well-designed rotaries, and the output is limited by the heating. So that it is safe to say, that, as a general rule, a rotary converter will carry a 50 per cent. overload for an hour or two without doing itself harm, and, as a matter of fact, it is found in practice that short overloads of 80 to 100 per cent. can be allowed with safety. This is naturally a great advantage in connection with the use of rotaries for railway work.

As stated already, a disadvantage connected with rotary converters is that the design is not flexible. The frequency determines the number of field poles and the speed. In order to keep the latter within reasonable limits, either the frequency has to be reduced to a very low value, or the number of poles has to be very large. If the former course is adopted, it means that generators and transformers are needlessly heavy, and that the polyphase mains are useless for anything but power work. If the frequency is allowed to be normal, say, from 40 to 60 cycles, then the number of field-poles becomes so large that proper commutation is rendered very difficult, and the diameter of the rotary becomes so great compared with its breadth that the employment of steel fields has to be abandoned, and everything has to be done to increase the stability of the machine. For these reasons, it has been found necessary to compromise in practice. The frequency is arranged as a rule to be between 20 and 30 cycles per second, and the speeds of the rotaries are made as high as possible. But it may be remarked here that if direct current dynamos were designed to have as many poles as the corresponding rotaries at the same speed and output, sparkless collection of the current would be impossible.

It is only because the effects of armature reaction are neutralised with rotary converters, that it has been found to be possible to run such machines satisfactorily, in spite of the excessive number of field poles.

The want of flexibility in the design of rotary converters shows itself in another way. As the ratio of the volts on the slip-rings to the volts on the direct current side is constant, being independent of the field strength and armature current, it becomes impossible to compound or over-compound the direct current side by usual methods. As over-compounding is invariably wanted for power work, it has to be done by special devices, outside the converter proper. There are three principle ways of compounding a rotary, all of which are used in practice. The first is by regulating the pressure supplied to the slip-rings by altering the secondary windings of the polyphase transformers, a multiple contact switch operated by hand cutting in or out secondary turns, as the case may be, and thus varying the pressure on the direct current side. The second method, very suitable for rotaries above 300 KW. output, is by means of a direct-coupled booster, which is mounted on an end bracket, and has an output of about 5 per cent. of the output of the rotary for the usual value of over-compounding required, namely, 10 per cent. The remaining method consists in using a compound winding on the field magnets, and choking coils inserted between the slip rings and the low pressure polyphase bus bars. A little consideration of the latter method will show that if the field current is so adjusted at a particular load, that there is neither lag nor lead on the polyphase side, in spite of the presence of the choking coils, then if the load diminishes, the field is weakened, owing to the smaller current in the series winding, and the polyphase current will lag; if the load increases, strengthening the fields, then it will lead. A lag means a reduction of pressure, and a lead an increase of pressure, on the polyphase side, thus diminishing or increasing the direct current pressure in accordance with the requirements of the load.

The last two methods described are perfectly automatic, although outside the rotaries. Of course, the good working of the last arrangement depends on the adjustments of the choking coils and of the field windings.

On account of the armature coils of a rotary converter forming a single winding, great care has to be taken not to inter-connect the direct current sides of different machines if the polyphase sides are inter-connected, or *vice-versâ*. Thus, for instance, if two rotary converters have to have their direct current sides joined in series for the purpose of feeding a three-wire network, the polyphase sides of the rotaries must not be connected together at the transformers. Either two sets of transformers must be used, or else one set having each phase arranged with two equal secondary windings. Otherwise a very complicated short-circuit would result.

The size of sub-station required for a given output at the same speed is about 30 per cent. smaller with rotary converters than with motor-generators. Naturally, the difference in the amount of floor space required by the two types is much greater than this, if the running machinery only is considered. But the rotaries require extra space for the transformers, and much larger switchboard, so that the actual difference in the size of sub-station works out approximately as above.

A summary can now be made of those points in which rotary converters come out better than motor-generators.

SUMMARY II.

1. Smaller floor space required.
2. Greater overload capacity.
3. Higher efficiency.
4. Higher power-factor.

(To be continued.)

Scholarship.—Mr. F. H. Nicholson has been nominated by the Council of the City and Guilds Central Technical College, Exhibition Road, to the free pupil Scholarship offered every three years by the Brush Electrical Engineering Company, Limited, to that Institution. The nomination has been duly accepted by the board of the Brush Company.

THE COST OF STEAM RAISING.

THE best way of proving the value of a fuel is to find the cost per 1,000 gallons of water evaporated. This is the line taken by Mr. Holliday in his paper read at the Electrical Engineers' Institution on November 23rd. The formula for finding cost is as follows:—Where C is the cost per 1,000 gallons in shillings, P the price per ton of coal, also in shillings, and W is the rate of evaporation per pound of coal,

$$C = \frac{P \times 10{,}000}{W \times 2{,}240} = \frac{4{\cdot}464\ P}{W}$$

We think, however, that Mr. Holliday is entirely in error in assuming that the price of coals varies exactly with the amount of heat they will evolve. Probably the price is more nearly related to the amount of heat they will evolve per unit area of grate in unit time. The formula considers only the cost of the fuel, not the incidental cost of labour, which is usually increased with poor fuel. Nor does it include the disposal of waste. However, Mr. Holliday simply proves what we have long contended, that the fuels of least cost in the market will usually produce most steam per shilling of cost.

With dust coke at 5s., Welsh dust at 10s., and large Welsh at 22s., evaporating respectively 6 lbs., 8 lbs., and 9 lbs. of water, the evaporation of 1,000 gallons will be 3s. 8d., 5s. 3d., and 10s. 11d.

Against the economy of the cheap fuels are several disadvantages, says the author. One is that more fuel must be burned in the same time. He should rather have said more material must be put upon the fires, for in actual fuel there is not much difference in the weight of combustible. The difference is usually ash, clinker and water. Though the cheap fuels are far cheaper per calorific capacity, they do not fetch a price equal to this capacity, because it is more difficult to use them, and it may cost a great deal to secure furnace capacity to deal with a fuel of inferior price. Hence the economy of forced draught, even if more wasteful than a less energetic draught, for with a reduction to one-third in the cost of evaporation, there is a margin to throw away by adopting a draught intensity which will enable the old furnace area to still maintain steam.

The author rightly sounds a note of warning against the practice of buying apparatus on a basis of fuel saved, for any new furnace ought to show an improvement on old half worn-out plant, and while the seller makes all the saving, the user is saddled with all the extra incidentals, such, for example, we may point out, as fan driving or wages in clinkering. The author cites a certain plant of nine Lancashire boilers using some Perret's furnaces with coke breeze and other ordinary bars with Martin's doors. He is not at liberty to give their owners' names, but from his description we think we know these boilers, or some under very similar conditions, using coke breeze at 3s. 6d. per ton, says Mr. Holliday. This fuel contains 22 to 25 per cent. of incombustible, an amount that might be prohibitive in some cases, but which is not always costly or difficult to remove. The above Lancashire boilers, all about 7 feet × 28 feet, return 170 H.P. at 20 lbs. of steam per H.P.-hour. This is about half of what such boilers ought to turn out, and points to one disadvantage of low quality fuels. It also points to the necessity for larger grate surfaces, and obviously to underfiring, for no larger grates can be got into Lancashire boilers than the furnace diameters allow of. The Perret furnace uses a fan draught of about 1·1 inch of water under the fire bars, and this was produced for the three boilers so fitted by a 36-inch fan.

In 1895 Welsh coal was chiefly used at this works in the six hand-fired boilers, and it cost 14s. 6d. per ton, and had a 10 per cent. content of ash, &c., and evaporated 9½ lbs. water. The cost per 1,000 gallons was thus 6s. 9¾d., a result so much above the 2s. 8½d. found for the breeze as to be very striking. The rate of evaporation was 3,800 lbs. per hour per boiler of 190 H.P., an advance of 11·7 per cent. beyond the results of the cheap fuel. The Perret furnaces, however, cost a great deal to clean out. The flues become filled with dust, and more is paid for clearing them out. More is paid also for cartage of all this dirt. The four

natural draught boilers cost 16s. 6d. per week for refuse removal, and 4s. 6d. for each boiler cleaned is also paid, whereas the forced draught boilers cost 40s. per week for refuse removal and 11s. 6d. for the amount removed from each boiler. It appears that of the water evaporated, 7 per cent. was used by the fan engine, but this is hardly fair to the fan principle in the absence of any statement as to the economy of the small fan engine.

Taking into consideration all the costs in each case, including insurances of all kinds, interest on plant and buildings, depreciation on same, due proportion of chief engineer's salary and of the cost of the spare plant, it appears that the cost of evaporation per 1,000 gallons comes out as follows:—For the forced draught boilers, 7s. 3½d.; for the natural draught boilers, 9s. 2d. The spare boilers cost 15s. 5¾d., and the cost for all boilers was 8s. 6¾d. There is thus a distinct saving from the use of cheap fuel with such appliances as were necessary to enable it to be used. In fuel cost alone the economy was considerably over 50 per cent., or 3s. 1·84d. against 6s. 8·47d. This ratio is, however, reversed in the items of wages, cartage, &c., and stores being 1s. 8·65d. against 0s. 11·9d. Maintenance and interest and all other items are heavier against the forced draught, and the net economy is brought to barely 2s. per 1,000 gallons, a sufficient economy, however, to warrant the outlay. The question of using a fan in place of a chimney is one that is rather coming forward at present. There may perhaps be less economy in capital expenditure between a fan and its motor and the chimney, and the fan, of course, requires to be driven.

But it must not be overlooked that, quite apart from the elasticity given to the system by the use of fan draught in case of fog or gloom, there is the possibility of using a much cheaper fuel. Mr. Holliday's paper is an excellent and practical paper, for he has endeavoured to take all points into estimate, and presented as unfavourably as possible the claims of the cheap fuel, but the advantage still remains with the cheap fuel. We may assume that the saving due to cheap fuel is practically about 2s. per 1,000 gallons less than the apparent saving per 1,000 gallons calculated on fuel cost only. This is for the very worst fuel—coke breeze—which Mr. Holliday finds to cost about 1s. 10d. extra to burn it, as compared with Welsh at the price named. Fuels better than breeze will no doubt involve less expense in incidentals and, though dearer than breeze, will still save considerably over the more costly fuels. Perhaps, indeed, the really cheapest fuel would be found low down in the scale of price, though not the lowest, and where the question of smoke has been solved, it is probable that a very smoky coal, abnormally cheap because of this quality, might prove very efficient.

In estimating the advantages of a fuel, regard must be had to situation, a river frontage and cheap barging of refuse being all in favour of the dirtier fuels. In many large works also there is an outlet for clinker for purposes of mortar or concrete for extensions and foundations, and it is said of a certain Cheshire salt works that nothing is ever taken off the ground, and yet this never succeeds in keeping itself many inches above water level, so constant is the subsidence due to brine pumping. As the price of Portland cement is now fully 30s. or even 40s. per ton, and hard boiler clinker has only cost a few shillings per ton to bring on to the ground, and would cost another shilling or so to remove it off the ground, it would be waste of time and money to carefully examine the coarse residue of the more coarsely ground cements with any idea of finding traces of boiler clinker therein.

INFLUENCE OF CHEAP FUELS ON THE COST OF ELECTRICAL ENERGY.

For years we have pointed out that the cheapest fuel that could be used for steam raising was, at usual market prices, that fuel which could be burned in sufficient quantity on the available grate area to do the work required. In other words, the price of fuel is not governed by its calorific capacity, but by the size of its particles. Large fuel can be burned at higher rates per square foot of grate than can small fuel. These facts, and their corollaries, have been proved for years. Apparently high rates of combustion should result in economy. Practical reasons often cause better results to be obtained from comparatively slow combustion. Small fuel can only be quickly burned by means of some kind of forced draught, but it is very difficult to apply forced draught to small fuel, for small fuel must be laid on a thin fire, and thin fires soon burn into holes, and can only be kept right by two means. One of these is constant agitation of the bars, and this is not practicable, because it causes so much waste through the bars. The other means is mechanical stoking on the sprinkling system. Doubtless a steeply sloped step grate, with the feed accelerated by gravity towards the foot of the slope, would deal well with small fuel, for this cannot fall through a step grate that receives all its air horizontally.

Mr. Crompton's inquiries have led him to discover that coal of inferior quality can be had at the pit's mouth for 2s. 6d. per ton, or perhaps, at this day of prosperity, at 3s. 6d., and that such coal, while excellent within a radius of 50 or 60 miles of the pit, because its total cost is only 5s. 4d. to 6s. 4d., is not so excellent at Chelmsford, where its total cost will be rarely under 14s.

As regards small bituminous coal, Mr. Crompton has rediscovered the fact that even in a coking stoking machine, where the fuel will coke to a mass, and so will not fall through the bars, it is difficult to get it pushed forward regularly. This is a fault which causes loss by reason of the excess of air admitted at the grates, and is one reason why such grates are made with such very narrow air spaces. It is also difficult to get rid of clinker. A coking stoker with a steeply inclined grate would, of course, get rid of this trouble, and it is so got rid of in America, where practically all boilers are underfired, and all the room required can be had under the boiler—an unfortunate impossibility with Lancashire boilers. We have pointed out frequently that inferior fuels were not to be dealt with by means of increased heating surface. The duty of a boiler remaining the same, no difference of heating surface is necessary for different qualities of fuel—merely differences of grate surface to suit the rates of combustion per square foot necessary to burn the weight of fuel necessary for the given duty.

Obviously, the externally fired boiler presents an easier solution of the problem than can the internal furnace, and Mr. Crompton suggests the use of a furnace so arranged that one portion performs the duty of igniting and caking the fuel at comparatively low temperatures. He advocates, in fact, the brick lined—or partially lined—furnace, which for years we have insisted upon as necessary for the smokeless combustion of bituminous fuels. Bituminous fuels cannot, except under exceptional circumstances—one of which is a right sort of engineer in charge—be burned smokelessly even in Lancashire boilers which have furnaces of the correct *form* for perfect combustion. It is because of its correct *form* that the Lancashire boiler is so good as it is, but its material is wrong. It is ridiculous, of course, to carry on a chemical process of a kind requiring high temperature in a crucible chilled to 350° or less. Yet this is what is attempted. In externally fired boilers the furnace sides can be made of brick, though the roof is of cold tubes. In the Scotch furnace of the Babcock boiler, even the cold roof is partly covered by fire tiles, and, so far, is thereby improved. Mr. Crompton has evidently had the opportunity of seeing a Juckes grate at work. We have repeatedly referred to this form of external furnace carried on a wheeled truck and fitted with a chain grate. We have seen scores of these Juckes grates at work, particularly in Yorkshire, and are glad to find the common knowledge of the North has filtered down so far as Chelmsford, where Mr. Crompton, by means of refractory lined combustion chambers and sufficiently reduced air excess, has succeeded in manufacturing a furnace product containing 11 per cent. CO_2.

He has tried regenerative tiles in Lancashire boilers in the form of a long arched bridge with pendant fins. We imagine the arch rather than its fin trimmings is the chief factor in the good results obtained. This bridge he places over the ignition area of the fuel. With Juckes furnaces we have seen a plain brick arch over the front end of the grate—and possibly used primarily to protect the front end plate rivets to shell plates—liquefy like treacle with the high temperature. The most refractory

brick must be employed. Probably it should be thin and cellular so as to expose a portion of the plates it protects, and thus somewhat the temperature reduce.

It appears that the revolving grate has been adopted by the Babcock & Wilcox Company, apparently from Mr. Crompton's description, almost as we know it under the name of Juckes, but with a back doctor plate of cast-iron to clear off the clinker and ash as the grate turns over the back end roller.

At Chelmsford, coal has been costing 17s. 5d. per ton. This amounts to 64 per cent. of the total cost per unit of the current delivered to the tool motors. The plant is of 250 KW. capacity, but averages only about 120 KW. of output for 54 hours and about 50 KW. during the 62 hours of night work. If the day rate had been maintained the fuel cost would have been about 76 per cent. of the total cost per unit, which would then stand at ·63d. With coal at 5s. 4d. per ton the coal cost would be 35 and 42 per cent. of the total in place of the above figures of 64 and 76 per cent.

The figures which Mr. Crompton gives in the table attached to his paper may be compared with others.

Mr. Crompton is always so very optimistic as to the cost of electrical energy, and we cannot think that his table accurately represents the cost as it would have to be set down in any public station, for example, Manchester, where coal, we may be certain, does not cost 17s. 5d. per ton, probably not 7s. 5d.; yet the fuel cost at Manchester is ·41; stores cost, ·16; labour, ·22, and repairs, ·31, or a total of 1·10 works' costs for nearly 5 million units. According to one set of calculations, the lowest total in England appears to be the ·87 of Bradford, where coal costs ·33d. per unit, and we know of those who have bought the best steam coal at Bradford for 6s., and very excellent coal for 5s. There is one lower, namely, Leeds, with ·78, of which coal accounts for ·25. We fear Mr. Crompton has underrated the cost per unit. According to his figures, Bradford and Leeds should not show more than ·30 or ·43 total costs. Assuming his fuel figures to be the more properly correct, it is evident that the cheaper fuel is the less costly, if its cheapness consists in the fact that it is small in size rather than small in calorific capacity, and that it can be utilised by simply increased grate area—not by increased total boiler plant. If a given boiler will perform certain work with round coal, it is folly to employ two such boilers with slack coal. This is, however, usual practice. In order to secure a larger grate surface, steam users practically use double the amount of steel plates, double the amount of brick seatings, steam pipes, dampers, and all accessories, where they could simply provide increased grate area alone.

Apropos of the whole question of bituminous coals, which are only at this late date receiving Mr. Crompton's tardy recognition, we would once again refer to the Wigan coal trials of the Manchester Steam Users' Association. It is many years since these trials of highly bituminous coals were made, and they proved the possibility of smokeless combustion in the furnaces of Lancashire boilers. Recognising the difficulty of securing the same skilled attendance as was, of course, obtained for the Wigan trials, we have always advocated some form of refractory furnace, so that the extremely critical conditions of combustion in water-cooled furnaces might be overcome and replaced by conditions of more certainty. The whole question of smoke is one of air admixture and temperature, and we think that if the extremely militant Smoke Prevention Committee, headed by Sir W. Richmond, wished to rid London of smoke, they would be better advised than they at present appear to be, if they would employ their funds in putting to work a boiler of some ordinary type, and showing how it might be made both smokeless and economical by some furnace construction which should embody the conditions we have so long advocated.

The country cannot afford to shut out of use its bituminous fuels, nor can it act on the dictum of one engineer who went so far as to state that the hydrogens of bituminous fuels must necessarily be all wasted, and, therefore, the calorific capacity of bituminous fuels was at most that of their fixed carbon constituents alone. We are, therefore, glad to see that Mr. Crompton has had at last the courage to emerge from the all-Welsh sect which has hitherto dominated south country electrical practice—not to its economic benefit.

ELECTRICAL SCHEMES TO COME BEFORE PARLIAMENT.

THE following is a list of some applications which will come before the next Parliamentary Session, as gleaned from the formal notices registered in the last few copies of the *London Gazette*. The list is not yet complete, but any further applications will be notified in a future issue. We have divided them off into three sections, viz., (*a*) electric lighting; (*b*) electric traction (tramways, light railways, and railways); and (*c*) miscellaneous :—

(*a*) ELECTRIC LIGHTING.

Name of place or town.	Description of powers.	Authority promoting.
Allerton, Much Woolton, Little Woolton, Cheldwall, and Garston	Revocation, alteration, or amendment of a certain provisional order, 1896, Electric Lighting Acts, &c.	Liverpool District Lighting Company
Alverstoke	... ...	Council
Banbury	... ...	Electrical Power Distribution Company
Barnet	... ...	Urban District Council
Barnstaple	... ...	Corporation
Battersea (St. Mary) ...	... ...	County of London and Brush Provincial Company
Berwick-upon-Tweed ...	... ...	Urban Electric Supply Company
Birkenhead	Extension of area of supply to Bidston-cum-Ford and Noctorum	Corporation
Bishop Auckland	... ...	County of Durham Electrical Power Distribution Company
Bishop Auckland ...	... ...	Urban Electric Supply Company
Bonchurch	... ...	Ventnor Electric Light and Power Co.
Boston	... ...	Corporation
Bredbury and Romiley ...	... ...	Urban District Council
Bridlington	Provisional order; manufacture & supply electrical apparatus	Corporation
Brierley Hill	... ...	Urban District Council
Caterham and Warlingham	... ...	Urban Electric Supply Company
Cheadle and Gatley ...	... ...	Urban District Council
Cheltenham	Extension of electric lighting to outside districts, Charlton Kings, Leckhampton, Prestbury, &c.	Corporation
Chester-le-Street ...	... ...	County of Durham Electrical Power Distribution Company
Cleckheaton	... ...	Urban District Council
Clecthorpes-with-Thrunscoe	... ...	Council
Cowpen (Northumberland)	... ...	Northern Counties Electricity Supply Co.
Dartmouth	... ...	Urban Electric Supply Company
Egremont	... ...	Urban District Council

(*a*) Electric Lighting —(*continued.*)

Name of place or town.	Description of powers.	Authority promoting.
Elland	... ...	Council
Enfield	... ...	Urban Electric Supply Company
Erdington	... ...	Urban District Council
Exmouth	... ...	Council
Farnham	... ...	Urban District Council
Felixtowe and Walton ...	... ...	Urban Council
Festiniog (North Wales) ...	... ...	Urban District Council
Garston	Provisional order, and extension of 1896 Allerton, Woolton, Childwell and Garston electric lighting order	Liverpool District Lighting Company
Glastonbury and Street ...	Various powers re gas supply, and as to electrical energy ...	Glastonbury Gas and Coke Company
Gosforth	Various powers and amendment of 1893 order	Newcastle-upon-Tyne Electric Supply Co.
Gosport	... ...	Council
Grantham	... ...	Urban Electric Supply Company
Harrow-on-the-Hill ...	... ...	Urban District Council
Heaton Norris ...	Transfer to Manchester Corporation	Urban District Council
Hebburn	... ...	Urban District Council
Heston and Isleworth ...	... ...	District Council
Hyde	... ...	Corporation
Hythe	... ...	Corporation
Jarrow and Hebburn ...	... ...	Walker & Wallsend Union Gas Company
Jarrow, Hebburn & Felling	... ...	County of Durham Electrical Power Distribution Company
Kendal	... ...	Corporation
Kingston-upon-Thames ...	Various powers, including electric lighting	Gas Company
Lambeth (part of) ...	... ...	S. London Electric Supply Corporation
Leek	... ...	Urban District Council
Limehouse	Provisional order, make and sell electrical apparatus ...	Board of Works
Littleborough (Lancaster)	... ...	Urban District Council
Liversedge	Provisional order & powers to manufacture & sell electrical apparatus	Urban District Council
London	Compulsory purchase of lands, establish generating stations, lay mains beyond districts of supply, &c.	County of London and Brush Provincial Electric Lighting Company
London	Compulsory purchase of lands in St. Saviour's Parish, new generating stations, and various powers, including as to depreciation account and reserve funds	City of London Electric Lighting Company, Limited
London	Powers for generating station at West Ham, connecting mains, &c., to City of London and other areas of supply; supply in bulk to authorities, &c.	Charing Cross and Strand Electricity Supply Corporation
London: Mile End Old Town	... ...	Vestry of the Hamlet
London (St. George's-in-the-East)	... ...	Vestry
Lymington	Construction of electrical works, &c.	Corporation
Lytham	... ...	Urban District Council
Malton (Yorkshire) ...	... ...	Northern Counties Electricity Supply Co.
Marylebone	... ...	Marylebone Electric Supply Company (19, Carnaby Street, Golden Square)
Maryport	... ...	Urban District Council
Meath, Briton Ferry and Aberavon	... ...	Electrical Power Distribution Company
Morley	Additional electrical powers, including supply of electricity to other authorities within or beyond the borough, dealing in electrical apparatus, alteration of date of electricity accounts	Corporation
Nantwich	... ...	Urban District Council
Newark	Prov. order and powers to manufacture and sell electrical apparatus	Corporation
Newcastle-upon-Tyne Electric Supply Company	Powers regarding Walker, Wallsend, Long Benton; transfer of Walker 1899 order; supply of electricity to Long Benton, &c.	
Newhaven	... ...	Company to be formed
Nuneaton & Chivers Coton	To purchase undertaking of Nuneaton Electric Company (revocation of 1898 order)	District Council
Penrith	... ...	Urban District Council
Prestwich	... ...	Urban Council
Ramsgate	... ...	Corporation
Redruth	... ...	Urban Electric Supply Company
Romford	... ...	Urban District Council
Royal Leamington Spa ...	... ...	Midland Electric Light & Power Co.
St. Helens (I.O.W.) ...	... ...	E. Ironside Bax and others
Salford	Supply electricity to districts adjacent to the borough, supply electric motors	Corporation
Sandgate	... ...	Urban District Council
Seaford	... ...	Company to be formed
Seaham Harbour ...	... ...	County of Durham Electrical Power Distribution Company
Sevenoaks	... ...	Electrical Power Distribution Company
Sheerness	Electric lighting powers, transfer of undertaking to another company	Electrical Power Distribution Company
Sleaford	... ...	Urban District Council
South Blyth	... ...	Northern Counties Electricity Supply Co.
Southwold	Electric lighting powers, including manufacture, sale, &c., of electrical apparatus	Corporation
Sowerby Bridge ...	... ...	Council
Spennymoor (Durham) ...	... ...	Northern Counties Electricity Supply Co.
Staines, Egham & Chertsey	.. ..	Electrical Power Distribution Company
Stamford	... ...	Urban Electric Supply Company
Sudbury	... ...	Corporation
Teddington & Twickenham	... ...	Richmond (Surrey) Electric Light and Power Company
Thirsk	... ...	Northern Counties Electricity Supply Co., 13, Mosley Street, Newcastle-on-Tyne, Sir T. Richardson, C. W. Fairweather, C. S. Vesey-Brown, and others
Totnes	... ...	Electricity Supply Company
Tottenham	... ...	Urban District Council
Tunstall	... ...	Urban District Council
Twickenham & Teddington	... ...	Twickenham and Teddington Electric Supply Company

(*a*) ELECTRIC LIGHTING.—(*continued.*)

Name of place or town.	Description of powers.	Authority promoting.
Uxbridge and District ...	... ...	Urban District Council
Wallington	... ...	County of Surrey Electrical Power Distribution Company
Wellingborough ...	... ...	Electrical Power Distribution Company
Weybridge	... ...	Urban Electric Supply Company
Whitefield	... ...	Urban District Council
Whitney	... ...	Electric Supply Company
Woking	Application for provisional order, powers to manufacture and supply fittings, &c.	Electric Supply Company

(*b*) ELECTRIC TRACTION (Tramways, Railways and Light Railways).

Aston Manor	... ...	Urban District Council
Baker Street and Waterloo Railway Company	Various powers for underground railways, subways, agreements, &c., electrical working, 4 feet 8½ inches gauge	
Barnsley	... ...	Corporation
Barnsley and District (extensions)	Light railways, Worsborough district, West Riding ...	British Electric Traction Company.
Batley	Construct and alter tramways, electrical powers, &c. ...	Corporation
Bedford	Construct and work electric tramways...	Corporation
Blackpool and Garstang (Light Railway)	... ...	Blackpool and Garstang Electrical Railway Co.
Blackpool, St. Anne's, and Lytham	Construction of tramways, doubling existing track, supply of electricity in Lytham, dissolution of company, and formation of new one, &c.	Tramways Company
Blyth and District ...	Light railway powers for Cowper and South Blyth ...	British Electric Traction Company
Bournemouth... ...	Various tramway powers, electrical working	Corporation
Bradford Corporation ...	Tramways construction and electrical working in Bradford, Farsley, Hunsworth, Birkenshaw, Clayton, and Queensbury; and various other powers	Corporation
Bredbury and Romiley ...	Construction and electrical working	Urban District Council
Brighton	Construction of tramways, generating station at Southwick, for electrical working; to alter date for making up electric lighting accounts, &c.	Corporation
Brompton and Piccadilly Circus Railway	Extension of time and other powers	Company
Burnley	Abandonment, reconstruction, and construction of tramways, increase of speed, electrical working, extension of electric lighting area, &c.	Corporation
Cardiff	Extension of borough boundaries, new tramways within and without existing area to be worked electrically, generating station, &c.	Corporation
Cambridge	Construct and work electric tramways in Chesterton and Cherry-hinton	Corporation
Charing Cross, Euston and Hampstead Railway Co.	Extension of time	
Christchurch, Bournemouth and Winton	Various electric tramway powers	Poole and District Electric Traction Company
City of Bath	Light railways	Corporation
City and South London Railway	Amendment of 1893 Act *re* tunnel for the station under City Road, Islington	Company
Croydon	Leasing line to B.E.T. Co.	Council
Devonport	Construct and work tramways, electrical power, transfer of electric lighting powers of East Stonehouse Urban District Council, and various other powers	Corporation
Ealing	Construction of lines, electrical working, current for lighting station	Urban District Council
Farnworth	New tramways, electrical working, electric lighting, further powers including supply of electric motors and apparatus	Urban District Council
Folkstone, Sandgate and Hythe	Electric tramways. New Romney to Folkstone, dissolution of Sandgate and Hythe Electric Company, &c.	Sandgate and Hythe Electric Company
Great Grimsby Street Tramways Company	Construction and working of tramways; power to enter into agreements with Corporation for supply of power to tramways	
Halifax	Construction of lines in and outside borough electrical working, &c.	Corporation
Hastings	Construction of tramways, underground cable to connect with Hastings, Bexhill, and District Light Railway, supply of electricity in bulk to other bodies; transfer to company of Hastings, Bexhill, and District Light Railways (Electric) Co., Ltd., undertaking	Company to be formed
Hemel Hempstead ...	... ...	British Electric Traction Company
Houghton-le-Spring and District	Construction and electrical working of tramways, &c. ...	United Kingdom Tramway, Light Railway and Electrical Syndicate
Huddersfield	Construct tramways, and use of electrical power; erect poles, &c., for trolley working	Corporation
Hurst	... ...	Urban District Council
Ipswich	Construction of tramways, agreements with tramway company, electrical powers, extension of electric lighting powers	Corporation
Kingston, Surbiton and District (Light Railway)	... ...	Greenwood and Batley
Kingston-upon-Thames ...	Tramways, electrical powers, supply of electricity, sell electric apparatus, &c.	Corporation
Knott End Railway Company	New railway acquisition and electrical working of Garstang and Knott End Railway Company; agreements for supply of electricity	
Knott End Railway Company	New railways in county of Palatine of Lancaster; acquisition of Garstang and Knott End Railway Company; powers to work both lines electrically; agreements as to supply of electricity, &c.	
Lancaster and Morecambe	Tramways purchase, working, constructing, use of electrical power, and supply of electricity to adjoining districts	Corporations
L.C.C. (Light Railways)...	Highgate; Clapham, Wandsworth, Putney, Battersea; Deptford, Shooters' Hill, Woolwich; New Cross, Lewisham, and Eltham	
Leamington and Warwick	Tramways, electrical equipment of new and existing, &c. ...	Leamington and Warwick Tramways and Omnibus Company

(*b*) Electric Traction (Tramways, Railways, and Light Railways)—(*continued*).

Name of place or town.	Description of powers.	Authority promoting.
Lincoln	Tramways to be electrically worked, and various incidental powers	Corporation
Liverpool	Construction and working of electrical tramways, and other powers	Corporation
Liverpool Overhead Railway Company	Construction of new lines, widening lift, further capital powers, &c.	
Liverpool	Various powers, including alteration and equipment of tramways	Corporation
London	Powers to use electric traction on tramways, re-construct lines for electrical working, erect posts, wires, &c.	L.C.C.
London	New tramways and electrical powers for Hampstead, St. Pancras, Islington, Poplar, Bromley, Camberwell, Newington, and various other districts	London County Council
London, Barnes, and Richmond	Construction and working electrical lines, power *re* sale and purchase of electrical energy, &c.	Company to be formed
London United Tramways Company.	New tramways, road alteration, compulsory purchase of land, extension of time, agreements with Councils, &c.	
Loughborough and District	Light railways, Parishes of Hathern, Dishley-with-Thorpe Acre, Garendon, Knightthorpe, Loughborough, Woodthorpe, Quorndon, and Mountsorrel, all in Leicester County	Loughborough and District Electric Traction Syndicate, 49, Queen Victoria Street, E.C.
Manchester	Tramways; Manchester and Salford electrical working, supply of electricity to other authorities, and transfer of electrical powers, &c.	Corporation
Manchester and Liverpool	Electrical express railway, generating station, &c.	Company to be formed
Mersey Railway Company	Powers as to working of railways of the company and Mersey and Wirral Joint Committee and Wirral Railway Co. and portions of railways of the Birkenhead Joint Railways of the London and North-Western and Great Western Railway Companies by electrical power; lands for generating stations	
Metropolitan District Railway	Various powers *re* land for generating stations, provisions as to electrical working of Metropolitan and Metropolitan District	
Middleton	Tramways to be worked by gas or electricity	Corporation
Morley and District ...	Electric tramways, Morley and Bradford, Drighlington, Gildersome, and West Ardsley	British Electric Traction Company
Newcastle-on-Tyne ...	*Re* leasing of lines to company	Corporation
Newport	Construct tramways and work electrically	Corporation
Nottingham	Various powers, including fixing brackets to buildings for tramway working	Corporation
Oldham	Road widening for tramways, fixing brackets to houses, &c., for electrical working	Corporation
Oldham, Ashton-under-Lyne, Hyde, and District	Light railway extensions in Ashton, Denton, Hyde and Dukinfield	Company
Peterboro' and District ...	Light railways	British Electric Traction Co.
Plymouth, Stonehouse and Devonport	Additional lines, electrical powers, &c.	Plymouth, Stonehouse and Devonport Tramways Co.
Portsmouth	Construction of tramways and working by electricity ...	Corporation
Preston	New tramways in Preston, Walton-le-Dale, and Fulwood; electrical powers, lighting of public streets and Corporation property by electricity, &c.	Corporation
Rawmarsh	Construction of tramways, electrical power, supply of electrical energy and electric fittings	Urban District Council
Reading	Construct and work electric tramways...	Corporation
Redditch	Construction of tramways, electrical powers	Urban District Council
Rochdale	New tramways; electrical working; agreements with local authorities for supply of electrical energy, &c.	Corporation
Rotherham	New tramways, electrical powers, generating stations, extension of borough and of electric lighting area, &c.	Corporation
Scarborough	General tramway powers and electrical working	Corporation
Sheffield	Construction of additional tramways, electrical working, &c. ...	Corporation
South Lancashire ...	Tramways, electrical powers, &c., in St. Helens, Bolton, Leigh, Eccles, Abram, and a number of other places in the borough of St. Helens, Bolton, Leigh, Eccles, and various other urban districts in the county of Lancaster. Generating station at Leigh	Company to be formed
South-Eastern Metropolitan Tramways	New lines in Counties of London, Kent, and Surrey; electrical powers, &c.	Company
Southport	Construction and working of electrical lines; agreements with companies; alteration of date for making up electricity accounts, &c.	Corporation
Southport and Lytham ...	Tramways, electrical powers, &c.	Southport District Tramroad Company
South Staffordshire ...	Sell, transfer, and adapt tramways for electrical power, &c. ...	Tramways Company
Spen Valley	Light railway extensions in Bradford, Dewsbury, Batley, Cleckheaton, Liversedge, Gomersal, Birkenshaw, Hunsworth, Heckmondwike, and Thornhill (West Riding). Purchase of lands in Dewsbury	British Electric Traction Company
Stockport	Construct and work tramways, use electrical power, supply electrical energy	Corporation
Tickhill	Light railways	W. M. Mackey and G. H. Newborn
Vale of Rheidol (Light Railway)	Power to work authorised lines by electrical energy instead of steam, to enter into agreements for the supply of energy	Company
Walsall	Construction and electrical working of tramways, supply electrical fittings, and other powers	Corporation
Walthamstow ...	... ...	Urban District Council
Wellingborough & District	Tramways construction, generating stations, and electrical powers	British Electric Traction Company
West Bromwich ...	Tramways, electrical powers, supply of electricity outside borough, and of electrical fittings, &c.	Corporation
West Ham	Construction of tramways, electrical working	Corporation
Weston-super-Mare ...	Construct and work tramways, electrical power, &c. ...	Weston-super-Mare and District Electric Supply Company
Whitechapel and Bow Railway	Various powers; extension of time, capital, agreements with other companies, &c.	Company
Wigan	Light railways in Pemberton, Ashton-in-Makerfield, Abram and Ince-in-Makerfield	Wigan and District Tramways Company
Windermere and District Light Railways	Light electric railways in Bowness-on-Windermere, Windermere, Ambleside, Troutbeck, and South Westmorland.	British Electric Traction Company
Wirral Railway ...	Powers for electrical working, agreements with the Mersey Railway Company	
Withington	New tramways; electrical powers	Urban District Council

(c) MISCELLANEOUS.

Name of place.	Description of powers.	Authority promoting.
County of Durham Electric Supply Company	Incorporate company, generate and supply electrical energy in bulk to lighting authorities, companies, &c., in part of the county of Durham, compulsory purchase of lands, &c.	
Coventry	To authorise regulations in regard to electrical fitting in houses and buildings, power to supply fittings, alteration of date of annual accounts.	Corporation
Lancashire Electric Power	To establish generating stations and supply electrical energy in the county of Lancaster.	Company to be formed
L. B. & S. C. Railway ...	Power to contribute toward cost of constructing City and South London Subway between their railway and London Bridge Station.	
Midland Electric Power Distribution & Lighting	Extension of area of supply authorised in 1893 and 1899 orders, to include additional districts and parishes in Stafford and Worcester	Midland Electric Corporation for Power Distribution
North Metropolitan Electric Power Supply Company	Incorporate company, generate and supply electrical energy in bulk to local authorities and companies in Middlesex, Hertford and Essex, compulsory purchase of lands, break up streets, &c.	
South Wales Electrical Power Distribution Co.	Supply of electricity in bulk. (See page 842 ELECTRICAL REVIEW, November 24th.)	
Tyneside Electric Power Company	Incorporation of company, supply of electricity in Northumberland and Durham, &c.	

RECENT LEGISLATION IN CONNECTION WITH ELECTRIC LIGHTING AND POWER STATIONS.

A DILIGENT search through the statute books for the last few years does not reveal any very striking development of the laws which regulate the institution and management of electric lighting and power stations. The Act of 1888 modified the rules of purchase by the local authority, gave the Board of Trade power by provisional order to vary the terms of purchase, and afforded protection to the public from open electric wires. It also enabled the Postmaster-General to require that supplies of electricity should be continued only in accordance with conditions and regulations made by him for the protection of telegraphic communication. Since this important statute no Act has been passed until the present year which directly affected the interests of the electrical world, although many of the public general Acts, such, for instance, as the Factory Act, 1895, and the Workmen's Compensation Act, 1897, are of much more than passing interest to those whose business involves the employment of large numbers of working men. To these it will not be necessary to refer at any length.

The last session of Parliament, however, saw placed upon the Statute Book two Acts which are, or may be, of considerable importance to those who provide the electric current for lighting and power. The first of these, the "Electric Lighting (Clauses) Act (1899)," which came into operation on October 1st, comprises an important schedule which is to become part of every provisional order made in respect of every district outside the administrative County of London. It applies, moreover, whether the local authority is or is not the undertaker. The text of the schedule (an abstract of which was published in the ELECTRICAL REVIEW for September 15th, 1899) differs in no material respect from the form of provisional order which may be found in the latter part of "The Law of Electric Lighting," (1890) by W. Shiress Will, Esq., Q.C., which was generally made use of when the undertakers were a company or person.

The passing of this Act has necessitated the issue of a new edition of the "Rules Made by the Board of Trade with Respect to Applications for Licenses and Provisional Orders, &c.," which last appeared in 1890. The one alteration made by these rules refers to the draft license, six copies of which must be deposited with the memorial. [See Rule VIII., Board of Trade Rules, 1890.] Formerly the draft was bound to contain [*inter alia*]—

1. The address and description of the applicants.
2. A description of the proposed area of supply.
3. A statement of the purposes for which a supply is to be given, viz., any or all of the public or private purposes specified in Section 3 of the Electric Lighting Act, 1882.
4. Provisions concerning the breaking up of streets, railways, and tramways, where powers are sought to be obtained by the license or order for those purposes. [See Sections 15—17 of the Schedule to the Electric Lighting (Clauses) Act, 1899.]

Conditions of supply. [See Sections 10 and 27—30 of the Schedule to the Electric Lighting (Clauses) Act, 1899.]

6. Provisions for securing the safety of the consumer and of the public from injury by shock, fire, or otherwise. [See Section 38 of the Schedule to the Electric Lighting (Clauses) Act, 1899.]
7. Provisions for enforcing the performance by the undertakers of their duties in relation to the supply of electricity, and for the revocation of the license or order where the undertakers fail to perform such duties. [See Sections 63—68 of the Schedule to the Electric Lighting Act, 1899.]

The particulars referred to in paragraphs 3—7 above must not now be set out at length in draft orders, but must be provided for by the incorporation of the Electric Lighting (Clauses) Act of 1899. [See Board of Trade Rules, September, 1899, *note*.] We have pointed out the various sections of the Schedule to the Act which have reference to the matters dealt with in the above rules.

In addition to the well-known power of compulsory purchase, which is vested in the *local authorities*, it is important to recollect that by virtue of Sec. I. of the Electric Lighting Act, 1888, no provisional order authorising the supply of electricity by any undertakers within the district of any local authority can be granted by the Board of Trade, except with the consent of such local authority, unless the Board of Trade are of opinion that such consent ought to be dispensed with, in which case they must make a special report, stating the grounds upon which they have dispensed with such consent. Moreover, there is nothing to prevent the granting of a licence or provisional order to the local authority, although a grant of authority to undertakers may have been previously made in the same area. The consent which must formerly have been obtained from the Vestry or certain district council, must be obtained from the new municipalities which may be constituted in accordance with the provisions of the London Government Act of 1899.

This leads us to examine the London Local Government Act of 1899.

"Within the limits of 35 sections," says Mr. Hunt in the preface to his work upon this Act, "none of them unduly long, and three short schedules, provision is made for the abolition of some 78 elected vestries, consisting of over 4,000 members, 12 district boards, consisting of nearly 600 members, one local board, consisting of 21 members, and one urban district council, and for the creation in their place of 28 borough councils, each of which is to consist of a mayor and not more than 60 councillors and 10 aldermen, or a possible grand total of 1,988 members. Women will not be eligible to serve on these borough councils."

The theory of the Act is simple. The unit of local government ceases to be the parish, although the parish is retained as the unit for rating purposes, and the administrative County of London outside the City is divided into 28 areas, each of which is to be a borough, and for each of which a borough council is to be formed; 16 of these areas are single parishes.

The following list serves to show at a glance the proposed re-arrangement of Greater London:—

PROPOSED BOROUGHS.

1. Battersea.
2. Bethnal Green.
3. Camberwell.
4. Chelsea.
5. Fulham.
6. Hackney.
7. Hammersmith.
8. Hampstead.
9. Islington.
10. Kensington.
11. Lambeth.
12. Paddington.
13. Marylebone.
14. St. Pancras.
15. Shoreditch.
16. Stepney. [Aldgate, Christchurch, Spitalfields, Limehouse, Mile End New Town, Mile End Old Town, Norton Folgate, Old Artillery Ground, Ratcliffe, St. George-in-the-East, Shadwell, Wapping, St. Botolph-without-Aldgate, and Whitechapel and Tower of London.]
17. Poplar. [Bow, Bromley and Poplar.]
18. Wandsworth. [Clapham, Mitcham (det.,) Putney, Streatham, Tooting Graveney, and Wandsworth.]
19. Southwark. [Christchurch, Newington, St. George-the-Martyr, and St. Saviour.]
20. Bermondsey. [Bermondsey, Horselydown, Rotherhithe, and St. Olave and St. Thomas.]
21. Holborn. [Furnival's Inn, Gray's Inn, Lincoln's Inn, Saffron Hill, St. Andrew, and St. George, and Staple Inn.]
22. Clerkenwell. [Charterhouse, Clerkenwell, Glasshouse Yard, St. Luke, and St. Sepulchre.]
23. Deptford.
24. Greenwich. [Charlton, Deptford St. Nicholas, Greenwich, and Kidbrooke.]
25. Lewisham. [Lewisham and Lee.]

26. Woolwich. [Eltham, Plumstead, and Woolwich.]
27. Westminster. [St. Anne, Westminster, St. Clement Danes, St. George, Hanover Square, St. James, Westminster, St. Margaret and St. John, St. Martin-in-the-Fields, St. Mary-le-Strand, St. Paul, Covent Garden, St. Peter, Westminster, Liberty of the Rolls, and Savoy.]
28. Stoke Newington. [South Hornsey and Stoke Newington.]

The Borough Council will be a local authority for the supply of electricity under the Electric Lighting Acts, 1882 to 1888. [See Hunt, "London Local Government," Vol. ii. pp. 797 to 809,] and may borrow money for the purpose of supplying electricity in all areas where the Borough Council is authorised to supply electricity. Another most important provision is that which enables the Local Government Board, in cases where the Borough Council is unable to purchase land, to empower that Council to put the compulsory provisions of the Lands Clauses Consolidation Acts into force.

By Section 4 (1) of the Act, on the appointed day (*e.g.*, the day fixed by Order in Council), every elective vestry and district board in the county of London shall cease to exist, and, subject to the provisions of the Act and of any scheme made thereunder, their powers and duties, including those under any local Act shall, as from that day, be transferred to the Council for the borough comprising the area within which those powers are exercised, and their property and liabilities shall be transferred to that Council, and that Council shall be their successors, and the clerk of the Council shall be called the town clerk, and shall be the town clerk within the meaning of the Acts relating to the registration of electors.

As we have pointed out, the Act does not come into force until a special order of the Queen in Council. No immediate changes need, therefore, be expected.

WATER SOFTENING.

In the treatment of feed water a great change of the conditions to be met has taken place during the last few years. This change is dependent upon increase of pressure. With higher pressures the temperature of a boiler is also higher, and where the scale-producing material is carbonate of lime, experience points to the fact that in entering a boiler which is at a high temperature the carbonate of lime is much more quickly separated out of the water and deposited in the immediate vicinity of the feed inlet. Probably this is because of the more rapid driving away of the carbonic acid gas which keeps the bicarbonate of lime in solution, and the loss of which at once permits the salt to deposit as mono-carbonate

As regards sulphate of lime, there is considerable doubt as to the solubility of this salt. It is said to render water permanently hard, and not to be deposited by heating the water up to boiling point. It is also said to deposit if the water is raised to 400°, but few boilers attain to this high temperature, and lime sulphate should thus not form scale unless it becomes concentrated by evaporation. But whether this be so or not, there is a form of incrustation which is of a peculiarly adhesive quality. We refer to the deposit of its contents of each molecule of water converted into steam at the surface of the plate. The water goes off as steam, and the freed molecule in a peculiarly fit state for the purpose adheres promptly to the plate. Sulphate scale is thus much more adhesive than carbonate scale, as well as less satisfactory to deal with by preliminary treatment.

Seeing that carbonate scale is so very quick to deposit in a hot boiler, we wonder that more is not done in the way of feeding the water at a high point in a boiler into the upper of a series of trays so arranged as to permit the water to settle and overflow from tray to tray, depositing its lime salts on ribs or oyster shells placed as surfaces for adhesion. Excepting where soluble salts concentrate in a boiler, we should like to see the time when the blow out tap is not required to regular use; for we have very little belief in its action as a remover of loose scale or mud, and we believe such impurities, even if not deposited before the water enters a boiler, should be deposited in trays within the boiler, not upon the plates of the boiler itself. Various scale prevention apparatus depend for their action on the heating of the feed by live steam in some vessel outside the boiler. This system supposes frequently that the feed is supplied cold. Any live steam heating ought, obviously, to come after an economiser. Unless an economiser adds a more than usual amount of temperature to the feed, the lime will not be deposited until the boiler is worked, but where deposit takes place in the economiser, it can be bored out from time to time. Of course, we would place no system before that of the primary treatment of the water before it even enters the economiser. But even the most approved of water-softening systems may be reduced to minimum dimension and cost where the feed is taken from a surface condenser. Any other system of working bears the stamp of inferiority excepting under exceptional circumstances.

With surface condensation the making up water required is small, and can be treated for scale at small outlay. Indeed, in many cases it will produce so small an amount of scale as to admit of being used untreated, for when only supplied with a small amount of scale-forming matter, the natural tendency of the boiler to rid itself of scale may be sufficient to overcome the tendency to form additional scale. With water from a surface condenser there is also a considerable scale-detaching effect, and it is rarely desirable to have the inside of a boiler absolutely free from scale, as they are when supplied with water from most moorland districts.

CORRESPONDENCE.

High and Low Speed Motors.

Referring to the letter in your issue of November 17th, under the above heading, signed by "Lente," I should have replied to this sooner but for my absence from town.

"Lente," on the one hand, advocates extremely slow speed motors for power purposes, and contends that he can buy them at a cheaper figure than given in the leading article of the Electrical Review of October 13th, and thus make it worth while to a user of motors to substitute slow-running ones for the ordinary quick-running ones.

In a subsequent article communicated by the present writer, it is pointed out that the figures and contentions contained in the original article of October 13th on this subject are substantially correct, and agree with the present writer's experience on the subject.

"Lente" begs to differ, and offers to bet £10 that a user of motors can buy a first-class motor, giving 4 B.H.P. at 300 revolutions per minute, for £67, or thereabouts, whereas the price quoted by the Electrical Review is about £112.

If a man were to come to one and offer to bet you £10 that he could buy a first-class felt hat for 1s., one would be liable to think there was a catch in it, and instead of taking the bet, would offer to put business in that man's way, provided he could supply a hat for 1s. to a specification which would warrant its excellence.

As a matter of fact, the prices of a motor, capable of doing about this output, as taken from the catalogues of Crompton's, Siemens's, Parker's, and the Electric Construction Company, appear to vary somewhere between about £90 and £110, depending upon the exact size of the motor, as the standard sizes do not in every case come out at 4 B H P. exactly.

I think it can be said that these four firms know as much about continuous current machinery—and have made as many motors for power work as anyone in the country, and, consequently, their prices for a first-class article may be looked upon as representative.

It is just possible that as soon as multipolar machines are made in any quantity for these smaller sizes, the prices may come down a little for the same speeds, but the above prices are based on the ordinary two-pole machine, which represents the present practice in this country.

If, therefore, "Lente" can go a step better, and obtain the size of machine in question (at retail prices), at the price he names, as well as other sizes of motors at corresponding speeds and prices, to the following specification, which will guarantee a good article, I feel confident that the readers of the Electrical Review, as well as the present writer, would like to know about it, and that business would be likely to result therefrom to "Lente's" advantage.

Specification.

Motor to be of the ordinary open type, and to be capable of developing 4 B.H.P. at 300 revolutions per minute for a period of six hours, with a maximum temperature rise at any part of 70° F. above the surrounding atmosphere.

Bearings, two in number, of the ordinary self-lubricating type.

Armature, drum wound, and fitted with carbon brushes.

Efficiency, after six hours' run at full load not to be less than 75 per cent.

Finish and Workmanship of the best.

Note.—The prices to be subject to the ordinary full trade discounts.

I think I am fairly conversant with what is and can be done in the continuous current line in this country, and I need only add that if machines of the same excellence can be purchased 25 per cent. below the market price, it would be very interesting and useful to know about them.

The Writer of the Communicated Article.

London, *November 28th*, 1899.

Electric Wiring.

Prof. Silvanus Thompson in his Presidential Address refers to the question of electric wiring and the importance of keeping down its first cost, and you also refer to the matter in this week's issue of your paper. Prof. Thompson is of opinion that this reduction in cost is to be effected by adopting an uninsulated return wire.

As I patented a system on these lines some seven years ago, and have continuously adopted it in all installations which I have carried out since then, the publication of the experience gained during this period may perhaps be of advantage at the present time.

The system was first introduced by me in the lighting of Hollycombe for Mr. J. C. Harkshaw in 1892, after having obtained the sanction of Mr. Tarrant, inspector of the Sun Fire Office. The installation was at first only for some 250 lights, but has since been extended to over 600. Mr. Tarrant himself made an exhaustive inspection, and subsequently expressed his approval in the strongest manner. Fortified by this opinion, I have never had any objection raised by any insurance company, although some 200 houses have now been wired by this system. At Fort William, also, where some 5,000 to 6,000 lamps have been wired by the same method, the result has been entirely satisfactory.

Major Cardew, when inspector to the Board of Trade, made an examination, and after taking sundry tests, also gave his approval, and passed the arrangements adopted.

I was curious at the time to know what form these tests would take, and Major Cardew explained to me that the question concerning which he wished to satisfy himself, related to the possible existence of a difference of pressure between the earthed electric conductor and other neighbouring earths, such as gas or water pipes, which difference of pressure, if present, might cause trouble from electrolysis.

On testing, however, no such effect could be detected to any appreciable extent, and all objection on this score was removed.

I think, therefore, that having been found satisfactory, and passed by the Board of Trade and the insurance companies, and having also endured the test of years, I may claim that my earthed water-tight system may now be adopted with confidence.

With regard to the saving of cost, experience shows that on an average this may be taken from 4s. to 5s. per lamp wired. There are other subsidiary advantages which I need not dilate on now, such as a decrease in the time required to carry out the work of wiring, and the absence of damage to walls, ceilings, and decorations.

Prof. Thompson would like the cost of wiring to be reduced to that of putting in gas pipes. This is, no doubt, desirable, but at the same time the comparison is hardly a fair one. It must be remembered that the electric wiring of houses is far more complete than the usual system of laying gas pipes. For instance, numerous switches are placed in convenient positions, and fuses and main switch-boards have also to be provided.

If these conveniences and safety appliances were omitted, and the wires taken straight off the mains, then the cost of wiring would not greatly exceed that of fixing pipes for gas. On the other hand, if this plan were adopted the advantages and safety ensured by the adoption of the electric light would be greatly minimised.

R. Frederick Yorke.

212, West George Street, Glasgow.
November 28th, 1899.

Tested Lamps.

I fully expected some able reader to make some remarks on a paragraph headed as above in your issue of November 17th, 1899.

It was most unfortunate that the names of those English makers of the lamps which the "Tested Lamp Company" publish cannot be given, as it would have afforded an opportunity for them to defend themselves, or at least some explanation.

I have tested a number of lamps at various times, my results appear somewhat different.

Does it appear likely for a moment that there is so great a difference between English-made lamps? You may find a difference of 15 per cent. in life, if all have the same candle-power, same efficiency and at the same E.M.F. if about a dozen of each maker are tried, but not one lamp, as you may get hold of a particularly good or bad one.

The information in this test is so very vague, and not at all what you might expect expert lamp testers to put before the readers of a highly technical journal.

1. A 200-volt 16-C.P. lamp is tested at 3 watts per candle. The photometered result is at 200 volts 19 C.P. at 3 watts per candle-power, after burning at 200 volts (I suppose) it becomes 200-volt 9-C.P. at 6·5 watts per candle-power, this means that after "running" the period mentioned, the current increases ·017 ampere, a considerable amount in a 200-volt 16-C.P. lamp.

2. A marked 100-volt 16-C.P. lamp.

Photometered result gives 100-volt 12-C.P. at 4·5 watts per candle, after burning 336 hours, it becomes 100-volt 9-C.P. at 6 6 watts per candle, this means after 336 hours the current increases ·0836, this, too, is an enormous amount.

Now, it is a well-known fact, that the less the sectional area a filament has, the lower should be the efficiency to obtain the same life, then how comes it that the 200/16 volt having about ·005 mm. sectional area is given at 3 watts per candle-power, and a 100/16, having about ·02 mm. section, is tested at 4·5 watts per candle.

Again, to me it is new to find a lamp consuming more current at the end of its life than at the start, these matters want a little more explanation before I can quite swallow all that.

My experience has been that as a lamp burns, the resistance of the filament goes up, and at the same voltage the current naturally drops proportionately, it being due to the volatilising of the carbon and disposition on the bulb sides; of course, the more efficient the filament the quicker the change in resistance.

I would inform the Tested Lamp Company that about ·75 watt per candle-power more should be allowed a 200/16 lamp than a 100/16, and a further ·5 watt per candle-power for a 100/16 than a 50/16, to procure the same hours of life with an approximately parallel curve.

See Mr. Preece's test of lamps; a study of these will give an immense amount of information.

Is it an agency for an "American" or "Continental" lamp that is showing? If so, let us be straight about the matter. But really such absurd statements cannot go unpassed, or to the uninitiated some damage may be done, and also to our English lamp trade.

English Electric Engineer.

Street Box Explosions.

My attention having been directed to accidents reported in the ELECTRICAL REVIEW of October 20th, 1899, as occurring in the Strand, London, and at Carlisle, from gas which had accumulated in the conduits, I beg respectfully to state that by the introduction of my patent junction box in main's circuit there would be no possibility of explosions.

I have pleasure in enclosing a copy of my completed specification for your information.

While there may be an objection to the box being over the street or road level, it need not in any sense be regarded as offering a street obstruction, no more than a Post Office pillar box; any little inconvenience from such a cause would be more than compensated for by the advantages gained; the present surface boxes should, from my point of view, be a thing of the past; if my box were adopted, there will be no more explosions.

F. D. Black.

[The specification to which Mr. Black refers is No. 29,676 of 1897.—EDS. ELEC. REV.]

Why not Sir Joseph?

It has now become fairly recognised as an unwritten law that the presidents of the great Institutions should receive the honour of knighthood, either during or at the expiration of their term of office.

The presidents of the Institutions of Civil Engineers, Mechanical Engineers, and Marine Engineers are all so honoured, and justly so.

But why should the president of the Institution of Electrical Engineers be omitted, and especially when he happens to have rendered such brilliant service to the cause of science and of practical engineering as our late president has done?

The honour conferred upon the presidents of the other

Institutions is, as most of us understand, for a twofold reason.

It is a recognition by Her Majesty, as representing the nation, of the status and usefulness of the Institution as a whole. It is also a recognition of the position which the president himself occupies in the world of science and engineering generally, the world in which he moves, and to the betterment of which he has devoted himself.

It is for exactly the same reason that a judge is knighted. It is a recognition by Her Majesty, as representing the nation, of the importance of the judicial office, and of the legal fraternity as a whole.

It is also a recognition of the man himself and of the work he has done. And similarly with the great medical and surgical bodies.

Surely on both accounts our late president is entitled to knighthood.

Surely the importance of the Institution of Electrical Engineers is now sufficiently established to warrant their being recognised by Her Majesty equally with the other great Institutions. One obstacle we very probably foresee in the matter. Our late president is, as we know, an exceedingly modest man, who would prefer not to be troubled with honours and rewards.

We know, too, that as plain Joseph Wilson Swan, he is greater than any title can make him, and that his name will go down to posterity as one, and not the least, of the brilliant band of able men who have made the Electrical Age.

After all,

> The rank is but the guinea stamp;
> The man's the gold for a' that and a' that.

But I think most of us would claim that, in this case, our late president should make one more sacrifice for the industry for which he has done so much and submit to the knightly stroke.

Engineers of to-day hold the position that knights and military leaders did in days gone by; and it is our right that our leader should receive the badge of knighthood.

Sydney F. Walker.

Bath.

A Tender Point.

With reference to the paragraph in ELECTRICAL REVIEW of this day's date on "A Tender Point," I beg to inform you that I am not entitled to any credit attaching to the plan of printing the schedules of specification in copying ink and arranging for their being readily detached in the manner indicated in the article referred to.

The point is, perhaps, a small one, but the article is wrong in stating that the plan is due to me. With your well-known reputation for accuracy, I feel sure you will be glad to avail yourself of a correction on even such a minor matter as this.

F. Baylay,
Capt. R.E.

War Office, S.W.,
November 23rd, 1899.

An Electricity Supply Question.

Possibly some of your readers may be able to give me some information as to the obligation which a supply company is under as regards applicants who have their own plant for lighting their premises, but who wish to have the company to fall back upon in case of a breakdown, or to take current from them when it may be convenient.

It is not reasonable that the company should have the expense of putting down extra plant in order to be prepared for such contingencies without any prospect of making any profit, and if the question has not been settled by a court of law, it is important to consider what is a safe attitude for supply companies and corporations to take up, and it will be interesting to know how such cases are dealt with in different places.

Supply Company.

Norwich, *November 28th*, 1899.

Signalling without Contact.

I have been greatly interested in the reprint of Mr. W. S. Boult's British Association paper on "Signalling without Contact," in Mr. James Swinburne's report, and in the subsequent correspondence in your columns. Mr. Boult's system is most comprehensive, as regards signalling, and the apparatus is ingenious without being complex. Given construction on engineering lines, as distinguished from electrical, there seems to be no reason why it should not be perfectly satisfactory as regards the exhibition of signals to the engine driver. Some of the points made—apart from the operation of the contacts magnetically—are especially valuable.

There is, however, one point with regard to such signalling which does not seem to be noted or provided for in the paper, or referred to in Mr. Swinburne's report. From fig. 20, particularly, and from the paper and report generally, I gather that Mr. Boult's system is entirely independent of the ordinary semaphore signals, and, whilst it may be superposed on the latter form, there is, really, no need for further signals of any kind such as are in use at present.

The levers of the present semaphore signals are, in order to prevent mistakes on the part of the signalman, interlocked with those of the points, so that only the signals relating to the points set can be lowered for the passage of a train. Mr. Boult's apparatus, used as a complete system, would abolish such control, and I do not see that any substitute for this most important safety device is suggested.

Unless something of the kind is provided, at least as efficient as the present mechanical interlocking, it would be possible to set the points for one line, and the signals for another with, under certain conditions, disastrous results.

J. Pigg.

There is nothing ridiculous or funny in the statement contained in my letter which appeared in your issue of the 10th ult., as to what a driver assumes in a fog. That statement is quite correct. It can be verified by reference to the rules of any railway company party to the Clearing House system.

I do not understand Mr. Boult's apparent objection to the quotation from Sir George Findlay, seeing that the quotation appears in his (Mr. Boult's) original paper. So many hard things are being said of the present fog signalling system, that the opinion of so eminent a railway man respecting it, cannot be too well known, and more especially so seeing the great improvements in that system that of late have taken place.

I regret that I did not make myself clear about the man I suggested would be required by the driver of an express. The man would be required to watch the working of the indicators, to calculate the road numbers ($M_2 + 2 =$ Branch No. 4, &c.), and watch the duplicate spots. Would it be fair to the driver to expect him to keep a look out along the line and watch these indicators also? A driver has something to look for besides signals, which, be it remarked, he does not implicitly rely upon. If he has to watch Mr. Boult's indicators, there will be a possibility of his not noticing some obstruction he otherwise would. I submit, therefore, that the question of the number of indications and road numbers a driver may receive in one minute is important, and if Mr. Boult will not admit 30 it would be interesting to know what he considers would be the maximum. I believe my estimate to be rather under than over the possible maximum.

I am still of opinion that it is not good railway signalling to have an indicator corresponding to a "stop" signal showing "off" on an engine when inside the Distant, if that "stop" signal is "on." There must necessarily be a liability of the indicator being misread.

In speaking of a wrong road number being given, I did not intend to refer to a mistake in the switching in the signal-box, but to a failure of one or other of the electro-magnets on the road, owing to which, although the switching was right, you might get on the engine, say, M_2 only, instead of $M_2 + 2$.

Until single-line signalling is seriously tackled by Mr. Boult, his system cannot be complete. If only electro-magnets are used Mr. Boult's *danger* signal is open to one of the very objections he raises against the *danger* signal of

other systems, as his medium on the road for operating the *danger* signal is then a varying one, the magnetic field not being permanent. Moreover, how can the switches that would be required for throwing these electro-magnets "in" and "out" be safely and efficiently controlled?

On the whole, perhaps, the *nursery* method is to be preferred to putting engine drivers to solve Mr. Boult's simple equations.

C. M. J.

"Earthing the Middle Wire."

Under the above heading you have in your last week's issue a paragraph (which you state is brought to your notice by Mr. Musgrave Heaphy) showing a possibility to-day of fire-risk in electric wiring as usually carried out with two insulated conductors installed on a three-wire main system in which the neutral is "earthed."

I venture to suggest that a note of interrogation should have been placed after your heading, or that the instance given could have been better described under the heading "Imperfect" earthing of the middle wire, for if the earthing "principle" was consistently carried out in the wiring of *houses* as well as in the streets, and any concentric system adopted in which one conductor completely surrounds the other, the possibility instanced could not occur.

It appears to me that Mr. Heaphy has unwittingly (or perhaps designedly) brought forward an instance which shows the fallacy of the present method of wiring—flourishing under existing insurance regulations.

From my point of view I would like to ask Mr. Heaphy what fire-risk possibility he can discover in a system of wiring in which two ordinary insulated wires forming the outers are installed in a steel armoured insulating conduit, of which the outer mechanical armouring or iron pipe forms the neutral and uninsulated earthed return?

Further, if such practice was generally adopted, it is obvious that the cost of wiring per light with steel armoured insulating conduit would immediately become *reduced one-half*, for, in other words, the present carrying capacity of the insulated wires would be virtually doubled by balancing the return current on to the pipe. The supplemental insulation on the inside of the pipe would effectually prevent "leakage," and, in the event of any fault occurring, rather invite a "short circuit" that would remove itself harmlessly.

Undoubtedly this question of consistently "earthing the neutral," involving as it does a general and complete adoption of the principle of permanently "earthing" one side of a circuit, is a very important matter, and the commercial exigencies of to-day will continue to bring the subject more and more prominently before the profession.

A discussion dealing with the question of "earthing" from all points of view would directly benefit many branches of the electrical trade. Your "Correspondence" column, however, could not be so burdened, and I must at present content myself with stating my belief that "earthing" does offer the *ultimate solution* to the question of providing thoroughly efficient and permanent electric wiring, at a price that would effectually check the further growth of gas-piping, and thereby secure the full field for electric lighting.

I also suggest that the practical efficacy and success of the principle of "earthing" depends mainly upon the *completeness* with which it is adopted, and the question of the present is how far existing lighting plants could be readily and economically changed over or adapted to meet the necessary requirements?

Fred. Bathurst.

63, Queen Victoria Street, E.C.,
November 29th, 1899.

Single-Phase Motors.

It is difficult to discuss with Mr. C. E. L. Brown. He continually argues points which are outside the question, and then exclaims with confidence, Am I not right! Under such circumstances further writing is of no value, and I'll therefore stop from the discourse.

Alexander Heyland.

The Dublin Cable Contract.

We have received from Mr. Wm. M. Murphy, chairman of the Dublin United Tramways Company, Limited, a long letter dealing with the matter of the Dublin cable contract, but in view of the letter from Messrs. Renshaw, Kekewich and Smith, which appeared in our last issue, we refrain from publishing it, as we assume that the matter is now *sub judice*.—Eds. Elec. Rev.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first subject to be discussed by the Institution of Electrical Engineers this session is the appropriate one of "the cost of steam raising"; it possessed a more than usual interest for many of those present on Thursday evening of last week owing to the phenomenal rise in the price of smokeless coal, and the positively astounding prices asked for even low grade coals. "The cost of steam raising" at a time when many stations are short of steam ought to elicit some useful and instructive remarks; no doubt, at the adjourned discussion, those who have felt the pinch will have something to say. Mr. John Holliday read his paper, and was followed by Mr. Crompton on the "Influence of Cheap Fuels on the Cost of Electrical Energy."

Mr. Ferranti opened the discussion by expressing the interest which attached to the two papers dealing with a most difficult problem, particularly so at this time of the year. Not only must steam be generated economically throughout the year, but in large cities fogs and sudden loads had to be faced. At the present time there was another difficulty due to the large quantities of coal required by the Government, and the demand was so great that there was little smokeless or Welsh coal to be had. In his own works at Hollinwood, an economy had resulted from the use of cheap fuels, but when an attempt was made to utilise any particular class of fuel which was cheap but not in demand, the supply of that fuel became exhausted or the price was raised and the economy hoped for was lost. One of the wants in some boilers was a large combustion chamber, and Mr. Crompton's large combustion chamber must and would give a large economy. When the temperature in a furnace was very high, due to forced draught or the use of highly calorific fuel, the condition became very like that in a blast furnace and great trouble was found in maintaining the brickwork, so the cost of renewal might be considerable. Those who had to deal with steam raising knew the value of an efficient and sufficient proportion of spare boilers, and a substantial spare was necessary for economy at the worst time of the year. Unless this were provided the deposit inside the boilers, and the deposit from the coal outside led to a reduced evaporation; to work boilers economically one had to be able to clean them systematically and thoroughly at all times of the year.

Mr. Stromeyer thought that Mr. Holliday's paper was especially valuable because of the very complete figures given. He referred to the objection to cheap coal owing to the amount of refuse produced and the cost of removing it, and that the large proportion of refuse made the effective thermal units less than were given theoretically. He found it convenient to state the cost of coal in pence for evaporating a ton of water, and showed that the value of coal was reduced to about a quarter if it gave 30 per cent. of ashes, as compared with what would be given if there were no ashes at all. He cited the attempts made to use shale oil as a cheap fuel, but the price increased, and it became uneconomical to use it. The statement by Mr. Crompton that 25 per cent. of heat was carried off with the products of combustion in one test of a boiler of the water-tube type at Glasgow, was characterised as absurd, but Mr. Crompton interposed the remark that the test was not his but one of Mr. Longridge's. Mr. Stromeyer thought there must be an error in the sampling of the gases. He further criticised the results obtained by analysis of flue gases, owing to the difference in composition in different parts of the flue. Externally fired boilers had always been unsatisfactory, and manufacturers did not like water-tube boilers, because with such boilers, when any

leakage occurred, one did not feel inclined to go on, but the boiler had to be stopped all of a sudden. He commended the dry-back boiler.

Mr. Dugald Clerk thought it quite a mistake that a gas-producer was going to do any good with a steam boiler; all attempts to do this had failed. The reason was that the carbon had to be converted into CO and then into CO_2; the result was that little more than 70 per cent. of the heat in the coal was used. The only way to avoid this was to have the whole producer in the boiler. He quite agreed that the water-tube type of boiler is not satisfactory to the ordinary manufacturer, but it has a very great advantage compared with the Lancashire boiler as it can be got into difficult inaccessible spaces and used with very high pressures, although in some cases it would pay better to stick to lower pressures and more economical boilers. The chief loss of economy is attributable to the radiation from the fire-brick furnace. When the fire was put into the centre of the water there are no such radiation losses, and the best results are obtained when combustion is not quite complete in a Lancashire boiler.

Mr. H. W. Miller mentioned some experiments he had carried out with special smoke-consuming fire-bridges. It was well known that in the ordinary standard pattern of Babcock-Wilcox boiler there was no real combustion chamber at all. By pyrometer tests the temperature of the flue gases is 800° to 1,000°, much too low to complete combustion. After fixing the fire-bridge of extended pattern the temperature rose to 1,200° to 1,600°.

Mr. Bertram Blount spoke on the chemical questions involved: many impossible figures were given, and the amount of CO_2 exceeded the total product of the combustion of the carbon burnt and the oxygen supplied. It was usually supposed by a great number of steam users that imperfect combustion led to a great loss: they may relieve their minds of that, to discover CO in the flue gases is most unusual. The neighbourhood might be ruined but their pockets will be safe. Again, on the question of gas producers, no one in his senses would use a gas producer for a steam boiler, he would use the gas in a gas engine.

Mr. G. L. Addenbrooke thought that electrical engineers were most interested in the comparative cost of raising steam in large and small plants. Three or four years ago he went into the question very largely, and it astonished him to find great difficulty in getting reliable figures. One of the troubles with cheap fuel was the oxidation which took place on exposure to the air, and its ready absorption of water.

The discussion was adjourned, and will be resumed at the next ordinary meeting.

THE HARGREAVES-BIRD ELECTROLYTIC ALKALI PROCESS.

By JOHN B. C. KERSHAW, F.I.C.

As a result of the criticism made upon the reports of Prof. Ramsay and Messrs. Cross and Bevan in last week's issue of the ELECTRICAL REVIEW, the writer has received from Mr. C. C. Connor, one of the directors of the General Electrolytic Parent Company, the appended figures relative to the average working efficiency of the Hargreaves-Bird electrolytic cell over a long period of time. Mr. Connor states that in the prospectus of the new company, which is to be issued to the public in the course of the present week, a current efficiency of 90 per cent. has been made the basis of the estimates. The figures given below confirm the opinion expressed by the writer, that the efficiency of 97·28 per cent. given in the reports of the experts was a *maximum* rather than an *average* efficiency, and it is satisfactory to learn that it has not been used in framing the estimates upon which the statements in the prospectus are based.

With reference to the suggested possibility that purification of the brine might be necessary before it could be used in the electrolytic cells, Mr. Connor states that in the recent experiments at Farnworth, brine prepared by dissolving rock salt in water has been employed without any purification, and that no difficulties have been met with since this method of preparing the brine was adopted.

The works will have a capacity equal to the production of 27,000 tons alkali and bleach per annum.

Days.	Amperes.	Volts at cell terminals.	Current efficiency.
360	(Av.) 2,048	(Av.) 3·926	(Av.) 93·405

Number of days	360 days.
Na Cl decomposed per 24 hours	220·037 lbs.
" " 360 days...	79,229·0 "

	tons.	cwt.	qrs.	lbs.
Na Cl decomposed per 360 days	35	7	1	17
Production as ash (Na_2CO_3) = (Na Cl × 9) ...	31	16	2	18
" soda crystals = (×2·444)	86	8	3	15
" of 37 per cent. bleach (×1·558) ...	55	2	0	14
" as bicarbonate (×1·435)	50	15	0	13

E H.P. at cell	10·778 E H.P.
Lbs. Na Cl decomposed E H.P.-day	20·42 lbs.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week ending Nov. 22nd, 1898.	Value £
Adelaide	73
Amsterdam	61
Bombay	140
Boston	45
Brussels	30
Buenos Ayres	100
" Teleg. mat.	701
Calcutta	500
" Teleg. wire	329
Cape Town	54
Christiania	460
Colombo	81
Copenhagen	84
Durban	2,246
East London	151
Gothenburg	103
Hamburg	110
Hong Kong	122
Launceston	90
Madras	38
Malta	157
Melbourne	75
Ostend	10
Penang. Teleg. mat.	118
Port Elizabeth	73
Quebec	100
Rio de Janeiro	32
Rockhampton	303
Rotterdam. Teleg. mat.	107
Senegal. 55 knots teleg. cable	167
Shanghai	93
" Teleg. mat.	1,087
Singapore. Teleph. mat.	58
Stockholm. Teleg. mat.	189
Sydney	1,023
Tientsin. Teleg. mat.	79
Vera Cruz. Teleg. mat.	33
Wellington	32
" Teleph. mat.	331
Yokohama	434
Total	£9,905

Week ending Nov. 21st, 1899.	Value £
Adelaide	442
Alexandria	709
Amsterdam	442
" Teleg. mat.	45
" Telephones	50
Antwerp. Elec. fuses	802
Barcelona. Teleg. cable	117
Bombay	471
" Teleg. wire	29
Brisbane. Teleg. wire	25
Buenos Ayres	225
" Teleg. mat.	135
Calcutta	122
Cape Town	310
Colombo	294
" Teleg. appts.	58
Copenhagen	26
" Teleg. wire	297
Demerara. Telephones	30
Durban. Teleg. mat.	1,575
East London	263
" Elec. tramcars	473
Gibraltar	173
Gothenburg	67
" Teleg. wire	19
Halifax. Teleg. cable	49,000
Hamburg	10
" Teleg. mat.	230
Hong Kong	183
Malta	96
" Teleg. mat.	566
Melbourne	10
" Teleg. mat.	110
Nelson	26
Ostend	62
Otago	22
Perth	65
Port Elizabeth	114
Rio Janeiro. Teleg. mat.	775
Santos	310
" Teleg. mat.	70
Shanghai	37
Singapore. Teleg. mat.	60
Stockholm. Teleg. mat.	136
Sydney	317
Wellington	67
Total	£58,314

Foreign Goods Transhipped.

Toronto. Teleph. mat.	Value £49

Electrical Wares Exported.

Week ending Nov. 29th, 1898.	Value £
Adelaide. Teleg. mat.	103
Alexandria	106
" Sub. cable	150
Antwerp	85
Brisbane. Teleg. mat.	101
Buenos Ayres	1,421
Calcutta	1,743
Cape Town	229
Christiania	84
" Teleg. cable	1·5
Colombo	105
Copenhagen	20
Durban	189
" Teleg. mat.	12
East London	108
Hamburg	110
Hong Kong	171
Kobe. Teleg. cable	65
Malaga	70
Melbourne	82
" Teleg. mat.	854
Port Elizabeth	26
Rio Janeiro. Teleg. mat.	5,186
Santos. Teleg. mat.	156
" Teleph. mat.	75
Senegal. 55 knots sub. teleg. cable	—
Shanghai	110
Singapore. Elec. detonators	243
Stockholm	1,700
" Teleg. mat.	85
Sydney	1,097
Valparaiso. Teleg. mat.	1,186
Venice	230
Yokohama	474
Total	£10,974

Week ending Nov. 28th, 1899.	Value £
Adelaide	475
Alexandria	284
Amsterdam	25
Barbadoes	20
Buenos Ayres. Teleg. mat.	742
Calcutta	236
" Teleg. wire	204
Cape Town	310
Christiania. Teleg. wire	31
Colombo	217
Copenhagen. Teleg. wire	49
Durban	169
East London	74
Genoa. Teleg. wire	70
Hong Kong	145
" Teleg. mat.	8
Lyttleton. Teleg. mat.	2,910
Madeira	90
Madras	38
Melbourne	141
" Teleg. wire	1,001
New York	24
Ostend	116
Otago	14
Port Chalmers	210
" Teleg. mat.	2,710
Port Elizabeth	377
Rio Janeiro	27
St. Helena. Teleg. cable	136,000
Shanghai. Teleg. wire	137
Singapore	45
Stockholm. Teleg. mat.	45
Sydney	459
" Teleg. wire	538
Tokio	90
" Teleph. cable	1,412
Trinidad	98
Wellington	41
" Teleg. mat.	473
Total	£149,580

Foreign Goods Transhipped.

Alexandria	220
Amsterdam	85
Bombay	25
Progresso. Teleph. mat.	188
Total	£468

Bankruptcy.—The creditors of J. C. Howell, electrical engineer, late of Queen Victoria Street, E.C., met last week at the London Bankruptcy Court. A statement of affairs was submitted, showing gross liabilities £19,120 (unsecured £10,348), and assets valued at £11,433, or sufficient to show a surplus of over £1,000 after meeting all liabilities. The debtor has been interested in numerous electrical companies, among the number being John Charles Howell, Limited; B. Howell & Son, Limited; Crompton-Howell Electrical Storage, Limited; Porous Accumulator Company, Limited; John Charles Howell (No. 2) Company, Limited; Epicycle Company, Limited; Epicycle Manufacturing Company, Limited, and Pontypool Electric Light and Power Company, Limited. He ascribes his position to the severance of his connection with the Crompton Company, and to the liquidation of John Charles Howell, Limited. In the absence of any offer, the creditors resolved to administer the estate in bankruptcy.

At the Lincoln Bankruptcy Court on 28th ult., W. H. F. Bowman, photographer and electrical engineer, Gainsborough, was up for public examination. The debtor attributed his failure to putting an electric light installation in the Albert Theatre, and never being paid for it.

A receiving order has been made on a creditor's petition against W. Rowbotham, electrical engineer, Teddington.

Liquidations, Dissolutions, &c.—The Electric Light Insurance and Maintenance Company has decided upon reconstruction and is winding up for that purpose, Mr. G. Bunbury, of Little Gadcombe Leigh, Reigate, being liquidator. The new company to be registered will have the same name.

Round's Accumulator Company, Limited, and the Power Accumulator Syndicate, are winding up voluntarily, with Mr. A. Pigram, of 70—71, Bishopsgate Street, E.C., as liquidator.

The Milver Portable Electric Battery Syndicate has resolved to wind up voluntarily, Mr. R. W. Palk, 105, Colmore Row, Birmingham, being appointed liquidator.

Books Received.—Kalender für Elektrotechniker, von F. Uppenborn, Siebzehnter Jahrgang 1900. München: R. Oldenbourg. 5 marks.

"The *Mechanical World* Pocket Diary and Year-Book for 1900." Manchester: Emmott & Co., Limited. 6d. (net.)

"Therapeutic Electricity," by W. S. Hedley. London: J. & A. Churchill. 1899. 8s. 6d.

Brown v. Laing, Wharton & Down, Limited.—In the Chancery Division of the High Court of Justice on Saturday, the 25th ult., the above matter (Brown *v.* Messrs. Laing, Wharton and Down, Limited,) was mentioned before Mr. Justice North on a motion for judgment. Counsel for the plaintiff said the action was brought by a second debenture holder, and the first debenture holders were not parties to the action at all. Minutes had been prepared which, according to the view of plaintiff's advisers, were sufficient. His Lordship said he should like to know what the inquirers said. A time might come when he (the judge) would sell the property. He thought the matter should stand over for inquiry, with leave to apply in Chambers for realisation. Counsel was granted permission to amend the writ which set forth that the plaintiff sued on behalf of himself "and all other debenture holders," whereas he was only a second debenture holder, and amendment was therefore necessary. There was another point: a receiver and manager had been appointed by Mr. Justice Darling in Vacation, the receiver without any limit of time and the manager until January 4th next. But there were a number of pending contracts which would not be completed until considerably after that date. His Lordship continued the appointment of receiver and manager without limit as to time.

Catalogues and Lists.—From the Thunderbolt Patent Governor Company, Limited, of Glasgow, we have received an illustrated circular particularising, with illustrations, the Thunderbolt governor, which has been already described in the ELECTRICAL REVIEW. An electric governor regulator is shown for controlling engines driving lighting or power generators. It is employed in combination with the air compressors and throttling cylinder, in order to vary the speed of the engine with a varying load and so maintain a steady voltage. A patent electric governor for small installations is also noticed. It is actuated by the electrical energy of the circuit, being arranged to act directly on the throttle valve of steam or gas engines in a manner described in the list before us.

Messrs. Polland & Co., of Newcastle-on-Tyne, have brought out a new price list of their "Beco" pocket volt and ampere-meters, which, we understand, are much in demand, both among large firms at home and the colonies, and have also been supplied to various Governmental departments for telegraphs, telephones, &c. The list has some comments regarding the application of the instruments to testing igniting apparatus in benzine and petroleum motor cars.

From Messrs. J. H. Holmes & Co. there comes to hand a copy of a newly issued catalogue of Lundell motors. This list is naturally of great interest and importance at the moment to all taking part in the development of electrical power transmission in factories, &c., for the Lundell motors are very widely used, and we understand that the demand is continually increasing both for home and foreign use. The demand is particularly marked from India and the East for the Senior type of ceiling ventilating fan motor which we find described. Some idea of the business being done by Messrs. Holmes may be gathered from the fact that of the two-pole and six-pole types of motors they have during the last three years supplied about 3,200 with an aggregate of 9,000 B.H.P. The motor has achieved great fame in America, the place of its birth, and the list before us is arranged in that beautiful manner which we have frequently mentioned as characteristic of American catalogues. The illustrations are worthy of the highest praise, and the neat way in which the matter and blocks are arranged, together with first-class paper and excellent printing, make the catalogue as good as anything of the kind that we have recently seen. Examining the contents more closely we find that the list opens with a general description of the motor, and there follows a table showing the intermediate powers for which the bipolar motors may be wound. Another table gives details of standard speeds, powers, &c., for multipolar types, and motors of various types are shown driving fans, emery grinders, dental outfits, lathes, pumps, linotype machines, wood-working and other tools, &c., and for organ blowing. Notes on motor parts, efficiency curves, and connection diagrams, are also interesting features of this excellent list.

The Electric Construction Company, Limited, have issued a revised list of their continuous current dynamos and motors. The list is capitally printed and has first class illustrations. A specification of E.C.C. standard two-pole dynamos is followed with tabulated details and prices of shunt and compound wound machines of various capacities. Direct current motors, and the Bushbury enclosed motors, also starting switches, resistances and regulators are described.

Mr. James Dickson, of Gray's Inn Road, W.C., sends us his latest lists of carbon brushes for dynamos and motors, the "Tieciton" dynamo brush, and the "Ideal" electric lamp guard.

From Messrs. Krupka & Jacoby, of Watling Street, E.C., we have received a catalogue of the Strela open and enclosed arc lamps. These lamps are made by the Stralsund Arc Lamp Factory, Limited, of Stralsund, for whom Messrs. Krupka are sole agents for this country and the colonies. The lamps as supplied for direct and alternating currents, for stage purposes as projectors, and arc lamp accessories, are described and illustrated.

We have received from the Fabrique d'Appareils Electriques Société Anonyme, Aarbourg, Switzerland, several neatly illustrated lists (October 1899) in which they describe and price their rheostats, regulators, switches for high and low pressure currents, and other specialities.

The Sparkless-Cleanser Company, of Nottingham, send us a circular of their "sparkless cleanser" for dynamo and motor users, for reducing wear and tear.

The Electrical Transmission Company, Limited, of Hammersmith, have issued some excellently printed and illustrated lists of the "Albert" knife switches and arc lamps and accessories.

Mr. W. Middlemiss has issued a new revised price list of switch blocks.

Messrs. Estler Bros., of Leadenhall Street, E.C., have issued a catalogue of high class mirrors, lenses, ship's lanterns, &c. In another list to hand from Messrs. Estler Bros., we find cuts and a few particulars of Ambroin trolley line material for which they are sole vendors for Great Britain and "Ireland." With "ambroin" it is claimed that fewer repairs are necessitated and an improved insulation is obtained; it possesses "high insulating qualities, resists heat, and is non-hygroscopic," claim the makers. This insulating material is composed of fossil copal and silicates, the silicates being saturated and mixed with the copal by a patent process, and after being subjected to a very great pressure, a strong, firm and uniform material is said to be produced. By varying the proportions of the component parts different qualities are obtained for different purposes. A glance through the list before us shows that line insulators of various shapes, large and small strain insulators, bracket arm hangers, sound dampers, arc lamp hangers, overhead frogs, trolley carf, wheels, harps, stretchers, turnbuckles and other things are made of this material at the Ambroin Works, Berlin-Pankow.

Changes of Address.—The Dalston Electrical Company have removed from 18, Ball's Pond Road, to 60, Stoke Newington Road, N.

Mr. F. J. Jones, electrical engineer, Princess Street Works, Chester, has removed to more commodious premises in Seller Street.

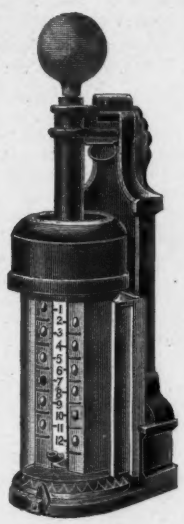
Dividend.—Die Fabrik Isolirter Drähte zer Electrischen Zwecken Gesellschaft, of Berlin, is declaring a dividend of 12 per cent. for the past financial year.

Dynamo Brushes.—We have received from Mr. C. Ford, 27, Clement's Lane, E.C., samples of his patent copper foil dynamo brushes. These are made of pure electrolytic copper sheet 0·0025 inch thick, doubled back and forwards to form laminated sheets 0·0025 inch, which are laid together to any desired thickness, and soldered together at one end. For these the advantages of high conductivity and small wear of commutator are claimed. We have received also samples of metal-paper for show cards, reflectors, &c., which are remarkable for their extremely brilliant colours and high polish.

Falcon Works Engineering Society.—The Falcon Works Engineering Society held their inaugural meeting of the present session on Wednesday evening, the 22nd ult., when Mr. R. Percy Sellon delivered the presidential address to a large attendance of members. Mr. Sellon passed in review the chief events of interest in electrical engineering during the past year and pointed out the tendencies of demand for electrical plant in their relation to the manufacturing industry. He laid stress on the necessity for specialising and standardising lines of manufacture to enable the British manufacturer to meet competition from the United States, Germany and Switzerland. Mr. Sellon concluded by explaining in detail the nature and objects of the additional buildings, plant and tools in course of erection, and further extensions which are in contemplation at the Falcon Works of the Brush Electrical Engineering Company.

Gutta-Percha Corporation, Limited.—Last week Mr. Justice North, in the Chancery Division, appointed a receiver and manager in a debenture holder's action against this corporation.

The Herzog Fairy Annunciator. — The apparatus which we illustrate below is a radical improvement in electric bell indicators or annunciators. It is new in principle and is adapted to replace any magnetic annunciator—or ordinary push button circuit—with ordinary open battery. Everyone is well acquainted with the cost and great space occupied by the ordinary indicator now in general use. Too often it is, in addition to the drawback of occupying a large space, an unsightly object in a very prominent position. The present invention is claimed to be anything but unsightly, to occupy a very small space, and to cost less than any indicator board now in use. The principle of operation is that the current passes from the push button to a corresponding positive disc connected thereto and immersed in a solution, then through the solution to a negative ter-



minal also immersed in the solution, the action of the current instantly decomposes chemicals in the solution and thereby causes the platinum disc to change colour. A twelve point indicator of this pattern will not occupy more space than a No. 2 Leclanché cell, is said to be most reliable in action, and can be adapted to replace any magnetic annunciator in any push button circuit. The inventors claim for it:—

1st.—Automatic restoration of the indications, which may be arranged to disappear independently of one another after any time within from 30 seconds to five minutes, according to adjustment, or by special provisions after a longer period if desired, thus making it unnecessary to reset the annunciator after every call, thereby avoiding the confusion which results when ordinary annunciators are used, and the attendant does not know from whence a call comes, because several drops are down owing to their not being previously replaced.
2nd.—The relative time when each call was made is clearly indicated.
3rd.—Visibility of all indications, because as the annunciator is so small, its entire face is within the field of vision at the first glance.
4th.—Compactness, simplicity, durability, and low cost.

The Hotel Great Central, Great Central Railway Terminus, Marylebone Road, and Hotel Russell, Russell Square, have been fitted throughout with "telesemes" on this principle by Messrs. Maple and Co., Limited. Messrs. C. F. Quicke & Co., 301—303, Euston Road, N.W., are agents for the apparatus.

In re River Plate Electric Light and Traction Company, Limited.—On Friday last, in the Chancery Division of the High Court of Justice, the above matter (Guinness and another v. the River Plate Electric Light and Traction Company, Limited,) was before Mr. Justice North. It was stated by Mr. Vernon, Q.C., that there were two plaintiffs in this suit—Mr. Herbert Frederick Guinness, acting in his own behalf and that of all other holders of the company's debenture stock, and Mr. Michael Bowden Snell, proceeding in his own behalf and all other holders of first and second debenture stock, he (the second plaintiff) being entitled to both sets of debentures. Counsel said that the company had issued first debenture stock to the amount of £150,000, and second debenture stock to that of £50,000; and the principal and interest had not yet become payable. Plaintiffs, however, were desirous of enforcing the debentures, and he (Mr. Vernon) now moved for the appointment of a receiver and manager, on the ground that the creditors of the company were pressing for payment and that the security for the debentures was in jeopardy. The company, the learned counsel further stated, had no funds wherewith to pay its debts or meet the current expenses of carrying on business, and it was impossible for it to obtain such funds. Therefore, Mr. Vernon submitted, a receiver and manager should be appointed in the interests of both sets of debenture holders. Mr. Cassel, who appeared for the company, did not oppose the application, which His Lordship said he should grant, but direct, however, that the receiver and manager should not act for more than four months without the leave of the Court. The receiver and manager would be at liberty to act at once upon the plaintiff's undertaking to be answerable for his security and upon his (the receiver's) own undertaking to complete his security forthwith.

Lead Poisoning.—As the result of an inquest touching the death of Robert Band, an employé of the Electrical Storage Syndicate, Clifton Junction, the jury returned the following verdict: —"That deceased on November 14th died from blood poisoning, arising from an ischiorectal abscess, and that such abscess was set up or induced by the anæmic condition of deceased, caused by lead poisoning."

Milver Portable Electric Battery Syndicate, Limited. —On Wednesday, November 29th, in the Companies Winding-up Court, Mr. Justice Wright, sitting as an additional judge of the Chancery Division, had again before him the matter of the Milver Portable Electric Battery Syndicate, Limited, on the petition of G. Trenam. This was a creditor's petition, and it stood over from the sitting of the Court on November 15th.—Counsel now informed the Court that the defendant had been paid, together with a sum for costs. There were no other creditors, and he (counsel) asked to be allowed to withdraw the petition.—His Lordship: You do so at your own risk.—Counsel: Certainly.—The petition was then withdrawn.

New Large Power Schemes.—The Tyneside Electric Power Company, Limited, are promoting a Bill in Parliament next session, empowering them to supply electric energy throughout the whole manufacturing district on both sides of the Tyne from Blaydon and Newburn on the West, to Tynemouth and South Shields on the East. The company propose to generate electric energy on a very large scale, and to supply it both in bulk to local authorities for distribution, and also for motive power purposes to works, shipyards and manufactories. Among the directors of the Tyneside company are the Hon. C. A. Parsons, F.R.S., and Mr. A. A. Campbell Swinton.

Press Directory.—*Street's Newspaper Directory* for 1899 is, as usual, a very useful index to the newspaper press of this country, and a few casual references which we have made have inclined us to describe it as accurate in its material and convenient in its arrangement. For the commercial man the book is the right thing, for it is a directory pure and simple, and does not attempt to import into it literary matter which will interest the literary man and nobody else. Such details as addresses, trades, date of publication, latest time for advertisements, are placed straight before the eye, and with the aid of a concise "contents" are always ready for reference.

Reduction of Capital.—The petition for reducing the capital of Hick, Hargreaves & Co., Limited and Reduced, will be heard before Mr. Justice Kekewich on December 2nd.

The Salignac Boiler.—At the time when this boiler was first brought out we drew attention to it in our columns. We have just received from Messrs. Salignac, Grille & Cie, of 67, Rue de la Victorie, Paris, a catalogue of their boiler, which is now made in various forms. This catalogue is a small treatise on evaporation. It may be remembered that the Salignac boiler is based on a principle which, if not new—for it was tried 50 years ago—is yet possible to-day, because of the excellence of the stout steel pipes now procurable. The principle of action is "never to introduce into the tubes more water than can be continuously evaporated." In this way the tubes are never gorged with water. Their receiving ends are restricted to the taking in of the quantity of necessary water that can be evaporated. It is claimed that a great reduction of heating surface can thus be effected, as much as two-thirds from ordinary practice. Circulation is active, and as much as 40 to 50 kilos. of steam can be produced per square metre of surface, or about nine to 11 lbs. per square foot = three times as much as ordinarily obtained. An ordinary form of boiler consists of an upper drum of water and steam space, containing a vertical pipe delivering steam near its upper part. This pipe springs from the top of a chamber placed below the drum. This chamber receives at its upper edge one set of ends and at its lower edge the lower set of ends of a series of long U tubes with their limbs nearly horizontal. The lower part of this chamber is connected by a pipe with the lower part of the upper drum. Water enters at the ends of the lower leg of the U pipes, is converted into steam in its passage through the pipes, and escapes to the upper drum by the vertical escape pipe, up which it also carries any water supplied by the down course pipe in excess of evaporation. Thus, as soon as the water reaches the level of the steam escape pipe, a mixed current of steam and water rises to the top drum, and in starting a boiler from rest the whole of the water contents are thus rapidly circulated and heated to improve temperature. The principle of the boiler appears good, and we should say it has a future.

Search Lights in the German Navy.—All the vessels of the German navy are equipped with the Schuckert searchlight projectors. The Royal yacht *Hohenzollern*, the man-of-war *Kaiser Friedrich III.*, and the gunboat *Hela*, which accompanied the German Emperor on his visit to this country, are, of course, included.

Sentence.—S. S. Clarke has been sentenced at Westminster to four months' hard labour for stealing moneys of the Safety Concentric Wiring Company.

Strike at a Chemical Works.—The shift men at the Castner-Kellner Electrolytic Chemical Works came out on strike last week. With these there also struck a number of other labourers, bringing the total up to about 100. The number employed at the works is about 400, and those in disagreement with the masters are employed in what is known as the "cell room," where chlorine gas is manufactured in oscillating cells of mercury, kept in motion by electrical power. Each man has the oversight of one row of these cells, and it was proposed that each man should overlook a row and a half in future, and that his wages should be reduced by 2s. 3d. per week. The men resisted this proposal by leaving their work. The

managers declined to treat with the men unless they resumed work, and a large portion of the employés did so. The men held a conference with the masters' representatives, with the result that they have agreed to work for a month under present conditions; the whole matter will then be reconsidered.

Smoke Nuisance.—At the Altrincham (Cheshire) Petty Sessions last week, the Altrincham Electric Supply, Limited, was summoned for not complying with a magistrate's order to abate the black smoke nuisance at their works. The Bench said the order must be complied with, but recognising the difficulties with which the company had had to contend, inflicted the mitigated penalty of 10s., and costs, 9s. 6d., on one information only.

Trade Announcements.—In consequence of Messrs. W. Tasker & Sons, Limited, giving up their electrical branch at 39, Victoria Street, S.W., Mr. Manley has made arrangements whereby he has taken same over and will continue the business in its same form. The "Moto" soldering iron, which has been giving great satisfaction, will be embodied in the business taken over by Mr. Manley, who will continue the sale of same under the same conditions.

Messrs. Edwards & Shaw, consulting electrical and mechanical engineers, of Birmingham, announce that they have purchased the interest of Mr. Cerrito in their late partnership business, and that their address for the future will be 105, Colmore Row. They will, as hitherto, confine themselves strictly to consulting work.

English Industrials, Limited, whose head office is at 55, Market Street, Manchester, has now opened an office at 82, Victoria Street, Westminster, S.W., for the extension of the various schemes and projects which are in hand.

Messrs. Worth & Handcock, boiler, &c., manufacturers, say that their works at Britannia Works, Cleveland Street, Birkenhead, are now completed, and most of the machinery is fixed and working, and that they are now ready for orders.

The registered offices of Sax, Slatter & Co., Limited, have been removed from 54, to 48, Gresham Street, E.C.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Electric Lighting Committee has instructed Mr. Bell, the electrical engineer, to prepare a report on the extensions and alterations likely to be required to cope with the increasing demand for electricity.

Backbarrow.—An electric lighting installation has been carried out in the Lancashire Ultramarine Company's mills by the Windermere and District Electric Lighting Company, Limited. Power is derived from a turbine driven by water from the River Severn.

Bala.—The Urban District Council has received the report of Mr. Peers on the electric lighting scheme, in which it is stated that a suitable outfit to supply 2,000 8-c.p. lamps and 40 20-c.p. street lamps would cost about £2,870. A ratepayers' meeting was called last week to discuss the report, when it was decided to defer the matter for 12 months.

Ballycastle.—A public meeting of the ratepayers was held on the 24th ult. to consider the proposed lighting of the town and quay. At present the town is supplied with gas, but the streets are not lighted. It was stated that the electric light could be installed at a cost of £1,500.

Barnstaple.—Mr. F. W. Chanter has been appointed electrical engineer to the Town Council, and is preparing a scheme for lighting the principal streets.

Battersea.—The Vestry last week resolved to oppose the application of the County of London and Brush Provincial Electric Lighting Company for a provisional order for Battersea. It was also decided to allow the contract with the Hart Accumulator Company for the supply of batteries to be so amended as to include certain clauses referring to the maintenance of the batteries as requested by the company.

Bognor.—Subject to an agreement being approved, the Urban District Council has accepted the offer of Edmundson's Electricity Corporation, Limited, to take over the Council's provisional order at cost price, and establish works for the supply of electricity in the district. Energy for public lighting will be charged for at 3d. per unit, for other purposes at 7d. and 4d. per unit on the Wright system; the Council may purchase the undertaking after 14 years for the capital expended + 33⅓ per cent.

Bury.—On Thursday, last week, Mr. E. A. Sandford Fawcett, on behalf of the Local Government Board, held a public inquiry into the application of the Town Council for sanction to borrow £800 for purposes of electric lighting. There was no opposition.

Carmarthen.—The Town Council last week decided to ask the South Wales Electrical Power Distribution Company for a statement of their terms for the supply of electricity for public lighting.

Cleethorpes.—The Urban District Council has received the report of Mr. C. S. Vesey-Brown on the question of electric lighting. The report recommends three-wire distribution at 230 volts, with street lighting by arc lamps on the tramway poles. The plant required would include steam dynamos of 120 kw. capacity, and a battery of accumulators, with a probable annual output of 147,000 units. The capital cost would be about £15,719. Electrical energy would be sold to private consumers at 5d. or 6d. per unit, and for public lighting at 3½d. The estimated total cost of the Cleethorpes electric lighting scheme is about £16,000, and the probable annual cost is given at £2,070. This, it is estimated, would enable the District Council to supply electricity to the public at from 5d. to 6d. per unit.

Cowes.—The Board of Trade has granted a further extension of the electric lighting order for six months.

Dublin.—The Corporation has concluded an agreement with Mr. R. Hammond, M.I.C.E., under which his appointment as consulting electrical engineer is settled. The extensions of the electric lighting scheme are to cost £120,000.

Edinburgh.—The Secretary for Scotland has sanctioned the borrowing of £210,000 by the Town Council for extensions of the electricity works.

Hoylake.—The District Council has accepted tenders, amounting to £20,660, for electric lighting buildings and plant. A Local Government Board inquiry is to be held shortly with reference to the application of the Council to borrow £26,000 for electrical purposes.

Italy.—A company has been formed in Naples with a capital of £120,000, to be known as La Società Napoletana per Imprese Elettrichi, to establish and operate central electric lighting stations in Naples.

Largs.—The Burgh Commission is considering the question of adopting electric lighting, and has obtained a favourable opinion on the subject from Lord Kelvin, at Netherhall, Largs.

Leatherhead.—The Urban District Council has received an application from Messrs. Handcock & Dykes, on behalf of a client, to purchase the Council's provisional order. The Council is prepared to consider any favourable offer.

Lowestoft.—Encouraged by a record season, the Corporation has decided to adopt electric lighting early next year as a municipal undertaking at a cost of £30,000.

Maidstone.—The Urban District Council has accepted tenders, amounting in the aggregate to £14,292 9s. 8d. (£3,000 less than the engineer's estimate), for the supply of plant for the electric light installation.

Morecambe.—A Local Government Board inquiry was held last week regarding an application by the Morecambe Council to borrow £25,390 for the extension of the electric light installation.

Northumberland.—Mr. A. A. Campbell Swinton has been instructed to report to the committee of the Northumberland County Lunatic Asylum upon the proposed electric lighting of the Asylum.

Poplar.—The Board of Works has accepted the tender of the British Insulated Wire Company, Limited, for supplying and laying cables; the necessary excavations and repaving will be carried out by direct labour.

Ruislip.—A local syndicate has been formed to promote an electricity supply undertaking in Northwood. The Parish Council has resolved to support the scheme in preference to that of the Uxbridge and District Development Syndicate, Limited.

St. Annes-on-the-Sea.—Colonel Durnford held a public inquiry, on Thursday last week, into the application of the St. Annes Council to borrow £18,000 for electric lighting. The assessable value of the district was given as £42,000, and loans already sanctioned, £46,000. Thirty years were asked for repayment of the loan, with the first two years' grace. The engineer estimated a gross revenue of £2,226, and a surplus, after the first year, of £274. There was no opposition.

St. Helens (I.O.W.).—The District Council has assented to the introduction of electric lighting in the district by the St. Helens Electric Supply Company, subject to purchase clauses being inserted in the order.

Sevenoaks.—The Electrical Power Distribution Company, Limited, has proposed an electric lighting scheme to the Urban District Council, involving a capital expenditure of about £20,000. The Council has appointed Mr. Hawtayne to advise on the subject.

Sheffield.—Last Friday Colonel W. Langton Coke, M.I.C.E., held an inquiry on behalf of the Local Government Board into an application by the Sheffield Corporation for sanction to borrow £100,000 for the purposes of the electric lighting undertaking. The town clerk informed the inspector that the electric lighting undertaking was purchased last year from the Sheffield Electric Light and Power Company by the Corporation, who entered into possession on January 1st this year. The undertaking was a large one, and was purchased at a largely enhanced value. The Corporation had practically no capital to work upon, and this was the first application for any loan in connection with the undertaking. At the time the Council took over the works the company had in hand the erection of certain buildings, extensions of their premises. These had been completed by the Corporation, who also needed money to purchase machinery, to lay street mains, and to do other work rendered necessary by the greatly increased demand for electric

light. Of the £100,000 a sum of £35,000 was for machinery, some portion of which was ordered before the Corporation became owners, and the remainder of which was either on order or would be wanted in the next few months. There was £20,000 for underground mains, and of this £10,000 would be expended during the year ending December 31st next. This was entirely for private lighting. There was a sum of £7,600 for public street lighting, but this was anticipatory. Nothing had been done yet in this matter, but it was anticipated that something would be done, and it was suggested that some of the principal streets should be lighted with large electric lamps placed on the standards of the electric tramway. There was £3,700 for extensions of buildings, some already carried out and some to be done; £7,000 for transformers and meters; £16,000 for boilers, and other appliances and other smaller items, with £5,000 for contingencies. Of the total sum £51,201 was the amount the Corporation had already spent, or were committed to, and £48,799 was for future works.

Sleaford.—The Urban District Council of Sleaford has given notice of its intention to apply to the Board of Trade for an electric lighting provisional order.

Swansea.—The Town Council has accepted the tender of Mr. David Jenkins for buildings for electricity works (£17,000). A Leeds firm is to be engaged to equip them at a figure of about £8,000. It is understood that it will take about six months to have the station completed, and it is expected that by next summer Swansea will have both the electric light and electric tramcars.

Train Lighting.—According to the *Echo* it has been decided to light all the carriages of the London, Chatham and Dover Railway by electricity.

Uckfield.—The Rural District Council has decided to make application for a provisional order enabling the Council to supply electricity in the parishes of Rotherfield, Mayfield, and Buxted.

Wellingborough.—The Urban District Council has approved of the terms of the provisional order to be applied for by the Electrical Power Distribution Company for supplying the town with electricity for lighting and other uses.

Winchester.—The Board of Guardians has decided to light a new laundry which has been added to the Workhouse by electricity, and has accepted the tender of Messrs. Dicks & Son, Winchester. It is probable that when the present contract for lighting the whole of the house expires, electricity will be substituted for gas throughout.

Wrexham.—The Town Council has received the sanction of the Local Government Board to borrow £20,000 for electric lighting purposes, to be repayable in 25 years.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barnes and Richmond.—The New General Traction Company has withdrawn its proposals to construct an electric tramway through Barnes and Mortlake to Richmond. It was part of the proposals that the Richmond Corporation should lend the company £60,000, but the Town Council was not satisfied what return it would get, and on the Council deciding to oppose the scheme the promoters took no further steps.

Bradford and Leeds.—The Board of Trade has recently confirmed an order authorising the construction of a light railway in the West Riding of the county of York from Bradford to Leeds.

Cinque Ports.—Among the schemes to come before Parliament is the Cinque Ports Light Railway, which will be a single line, 3 feet 6 inches gauge, and worked on the overhead electric system. The scheme is a very extensive one, and will provide convenient communication at a part of the country where such is sadly lacking at present. It is proposed to run from Ramsgate, forming a junction there with the Isle of Thanet Light Railways, which go to Westgate, Margate, and Broadstairs. It will run partly over private property, but chiefly along the road through Sandwich, Deal, Walmer, Kingsdown, and St. Margaret's. There will be a branch from St. Margaret's Bay to Martin Mill Station, thus putting St. Margaret's Bay and the adjacent country in direct communication with the London, Chatham and Dover Railway. From St. Margaret's the railway will run across fields, touching several farmsteads, until it joins the main road above Castle Hill, down which it will run, making junction with the Dover tramways in the Market Square. The *Dover Standard* says that negotiations are to be opened with the Dover Corporation for running powers over their line to Maxton. From Maxton it will run along the main road through Folkestone, Cheriton, Shorncliffe Camp and Seabrooke to Hythe, making junction with the South-Eastern Railway Company's tramway to Sandgate. From Hythe the line will run along the sea-front road through Dymchurch to New Romney. From New Romney the route runs through Lydd across the Marsh to Rye. From Rye the railway will run through Winchelsea to Hastings, and it is proposed to form connection with the proposed Hastings and Bexhill lines.

Darlington.—The Imperial Tramway Company has notified to the Darlington Town Council its desire to restrict the proposed tramways, omitting Eastbourne, Victoria Road, Grange Road, Greenbank, Haughton, &c. This restriction of the scheme will be shortly considered by the Town Council.

Falkirk.—A proposal is on foot to lay down electric tramways in Falkirk on the overhead trolley system. The Town Council has favourably received the proposition.

France.—A company has just been formed in Paris with a capital of £120,000, to be known as La Compagnie des Tramways Electriques de Vanves à Paris et Extensions, to construct and work an electric tramway between Vanves and Paris. The line, which is already in hand, is to be on the Diatto system.

Garston.—Notice has been given to the Urban District Council by the Garston Electric Lighting Company of its intention to apply for Parliamentary sanction to the construction of electric tramways from Aigburth Vale to Garston. The Council decided to oppose the application.

Glasgow.—At a meeting of the Tramways Committee of the Corporation held last week, the tenders for the two auxiliary engines required for the electric power station at Port Dundas were under consideration. The highest offer, which was by an English firm, amounted to £29,350; while the lowest offer, which amounted to £7,858, was by an American firm. The latter did not, however, comply with the specification, and it was agreed to recommend acceptance of the second lowest offer, which amounts to £7,870 10s., and is by Messrs. Duncan Stewart & Co., Limited, London Road Ironworks. It was also agreed to recommend that the offer of the Westinghouse Electric Company, Limited, London, to supply the switchboards required at the Port Dundas electric power station and at the sub-stations throughout the city be accepted. The contract amounts to £33,593.

Gravesend.—The Town Council has received notice that application is to be made to the Board of Trade for its approval to the transfer of the undertaking of the Gravesend, Rosherville, and Northfleet Tramways Company, Limited, to the Drake & Gorham Electric Power and Traction Company, Limited, of 66, Victoria Street, E.C., in consideration of £7,750.

Mersey and Wirral Railways.—Major Cardew has been engaged by the Mersey Tunnel Railway, and Mr. S. B. Cottrell, manager of the Liverpool Overhead Railway, by the Wirral Railway Company, for the purpose of preparing plans for the electrical equipment of the above railways.

Newcastle.—The New Tramways Committee last Friday decided to recommend the Council to accept the following tenders for plant:—Dick, Kerr & Co., 5,000 tons 45-foot steel rails at £8 7s. 6d. per ton; ditto, fish plates, at £9 17s. 6d.; Patent Nut and Bolt Company, Limited, 250 tons of patent nuts and bolts, &c., at £18 10s.

Portsmouth.—At a meeting of the Town Council on Tuesday the Tramways Committee presented a report recommending the adoption of a separate power station. Mr. H. Kimber, chairman of the Committee, in moving the adoption of the report, said the figures had been carefully examined, and the Committee felt that a separate power station would be best for the interests of the borough, and that as it would be a separate commercial undertaking it should stand on its own merits. There would be no additional outlay in the case of a separate power station, as the same outlay would have to be made by the Electric Light Committee if the Council decided that the current should be supplied from the electric light station. The figures had been very carefully prepared by the tramways engineer (Mr. Rotter), and they felt that they could produce the current more cheaply than the Electric Light Committee. Mr. Alderman Ellis, chairman of the Electric Light Committee, advocated the supply of the power from the existing station, but, after a long debate, the Committee's recommendation was adopted by 31 to 9.

Stirling.—The proposals of the British Electric Traction Company to take over the Stirling and Bridge of Allan Tramways and to extend the line to Tillicoultry, have been finally broken off. The points in dispute were the terms for street wayleaves and the sum to be paid the Council for the privilege of running the tramways.

Stourbridge.—An electric tramcar last week ran into a cartload of carboys of vitriol in the early morning before daybreak. The carman was seriously injured by the vitriol, and the motorman broke his leg. The car also was much damaged.

Warrington.—The Town Council on Tuesday resolved that application be made to the Board of Trade for a provisional order authorising the Council to construct and work tramways in the principal thoroughfares of the borough. The scheme embraces 11 tramways with four main lines. It was stated that no doubt the motive power would be electricity. The estimated cost of the scheme is £170,000.

Whitehaven.—The *Whitehaven News* is informed that a proposal has been made to the Corporation by a substantial company seeking to acquire powers to run a tramway through the borough on the overhead wire system. The line would pass from Cleator Moor, through Whitehaven, to Distington.

TELEGRAPH AND TELEPHONE NOTES.

Constantinople.—In view of the increase of telegraphic correspondence between Constantinople and Syria, and the delay in the transmission of messages, the Sublime Porte has, says an exchange, instructed the Administration of Ports and Telegraphs to double the wire between Constantinople and Damascus.

Edinburgh and the Telephone Service.—The town clerk has issued a report to the members of the Lord Provost's Committee of the Town Council relating to the public telephone service within the city. The report deals at length with the present position of the telephones within the city, of which the National Telephone Company has a practical monopoly. Among other questions the report considers the question which has arisen as to the interference with the streets involved in an underground system, the opinion being expressed that an adequate and efficient telephone service can only be had through an underground system with twin wires. The Town Council attaches the utmost importance to maintaining the control of the streets. They hold that the power of the Postmaster-General, with the consent of the Town Council or upon appeal, to lay underground wires in the streets was only intended to be used when necessary for Post Office purposes, and that it remains to be determined whether the Postmaster-General is within his legal rights or has exceeded them, in coming to the aid of the company in that matter. The report further discusses in detail, as possible alternatives to the present system, Government or municipal services, and it embodies a proposed agreement between the Corporation of Edinburgh and the National Telephone Company in the meantime. The main points of that agreement are given as follows in the *Glasgow Herald*:—

The Corporation shall retain control of the streets; they will lay underground wires between the points desired by the company, but the particular line of route will be in the discretion of the Corporation, who may from time to time alter the position as they find desirable. The company undertakes to give telephone service to all persons within the city on equal terms, irrespective of their distance from an exchange, and to maintain an adequate and efficient service; the Corporation reserve all their rights in the streets; the maximum rate of subscription charged for service will be in the subscriber's option at one of the following rates:—(*a*) Unlimited service at £10 per annum; (*b*) a fixed charge of £3 10s. per annum, with an addition of 1d. per call, without any charge for messages received—the latter "toll" system would probably bring the telephone within reach of many citizens who do not take it at present; the company is to pay a yearly rent of not less than £750 to the Corporation for the use of the streets; on December 31st, 1911, or within six months thereafter, the Corporation will have the option either to call upon the company to remove the tubes, &c., in the streets, or to take these over from the company at a valuation by arbitration. The agreement, which is subject to the approval of the Town Council within two months, it is pointed out, does not prevent or interfere with the Government or Post Office taking up the telephone service at any time. It does not interfere with the municipality obtaining a license and starting an independent service at any time, on the statutory conditions which would be applicable if there was no agreement. Moreover, it has the positive advantage, in the event of the municipality establishing a competing service, that it would have the effect of preventing the company from unduly reducing its rates for the purpose of driving off the municipality, as it might do if there was no agreement. It retains to the Corporation control of the streets, and it secures adequate and efficient service to subscribers, on terms which will allow the use of the telephone to become more general than hitherto, and it produces a substantial yearly rent to the Corporation which would otherwise not be had.

French Cable Schemes.—A Paris despatch says that at the meeting of the Cabinet there on Tuesday, the Ministers considered a proposal by M. Henrique, President of the Colonial Council, to facilitate the laying of a system of submarine cables by French enterprise. M. Millerand, Minister of Commerce, was instructed to draft a Bill in conformity with the views of the Colonial Council. The Bill will probably be laid before the Chamber during the first or second week in December. It is estimated that the cables cannot be laid in less than five years.

The Interruption to South African Cables.—Mr. Chamberlain pointed out to a deputation which waited on him in support of the claims of the Eastern group of cable companies, that when trouble occurred in South Africa, some of their cables had a habit of breaking down. We have had two examples of the correctness of this opinion during this last month. The cable from Delagoa Bay to Mozambique (an unduplicated section) broke down on November 15th. The cable between Aden and Zanzibar, also unduplicated, broke down on the 25th. In giving evidence *re* the Pacific cable, the Marquis of Tweeddale and his colleagues pointed out the necessity of duplication, saying, "We have gone on that principle of spending our surplus revenue in triplication and duplication." The cases to which we refer along the East Coast of Africa appear not to have been present to the minds of these gentlemen when giving evidence.

The Pacific Cable.—The *Sydney Daily Telegraph*, after having printed an article evidently inspired by the advocates of the Cape-Australia cable, and in which article the usual misrepresentations appear, corrects itself as follows:—

In regard to what appeared in yesterday's issue as to an agreement come to between the Postmasters-General of Victoria and New South Wales, the Postmaster-General assures us that the information on which the article was written was erroneous, and that the facts are as follow:—Since the present Government came into power, an advisory board has been appointed, representing Great Britain, Canada, New South Wales, Victoria, New Zealand, and Queensland. This board is to consider the whole matter of the Pacific cable, and advise the interested parties as to the result of its deliberations. The board meets in London early next month, and until the Postmaster-General receives its report, he points out it would be ridiculous for him to come to any decision on the proposals of the Eastern Extension Company. The Eastern Extension Company submitted certain proposals to the Colonies concerned, and all that has been done, so far, has been for the Postmasters-General of Victoria and New South Wales to ask the agent of the company if the company were prepared to vary those proposals in certain particulars, so that they might have all the information required before them when the report of the advisory board was received.

Reported Fast Speed Telegraphy.—It is telegraphed from New York that the Pollak-Virag system of rapid telegraphy has been tested between Chicago and Buffalo, and 90,000 words an hour were transmitted. Between Chicago and Milwaukee 140,000 words were sent in the hour. The distance from Chicago to Buffalo is 1,062 miles. Herr Virag superintended the experiments.

The South African Cables.—The Eastern Telegraph Company notified that the first section of the new cable between South Africa and England (Cape Town-St. Helena) was completed and opened for traffic on Sunday. The ship conveying the second portion of the new cable (viz., the section between St. Helena and Ascension) was due at St. Vincent on 28th ult., and it is expected that the section will be laid and open for traffic in December.

It has been since announced that another breakdown in the telegraphic connection with South Africa has occurred, the Aden-Zanzibar cable being now interrupted. This implies that telegrams from the seat of war will be again subject to delay, as all news will have to be transmitted by the West Coast cable. It is hoped, however, that the broken cable will be speedily repaired. The West Coast cable, it is understood, is at present working well, and, so far, with little delay.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies:—		
Jamaica-Colon	June 30, 1899 ...	...
Trinidad-Demerara (1871 original)	Oct. 20, 1899 }	Nov. 9, 1899.
Do. do. (1891 duplicate)	Oct. 6, 1899 }	one cable restored.
Do. do. (both cables)	Nov. 22, 1899 ...	Nov. 23, 1899
South African:—		
Zanzibar-Mombasa	Oct. 27, 1899 ...	...
Aden-Zanzibar	Nov. 27, 1899 ...	...
Cayenne-Pinheiro	Oct. 11, 1899 ...	...
Latakia-Cyprus	June 20, 1899 ...	...
Landlines.		
West Indies:—		
Cuban Government lines... ...	Oct. 30, 1899 ...	...
Communication with Les Cayes (Haiti)	Nov. 22, 1899 ...	...
South African:—		
Communication with Mafeking...	Oct. 13, 1899 ...	...
Communication with all offices beyond Orange River	Oct. 18, 1899 ...	...
Communication beyond Burghersdorp, Cape of Good Hope, and Estcourt, Natal...	Nov. 7, 1899 ...	...
Communication with north of Mooi River (Natal)	Oct. 21, 1899 ...	...
Colombian Government lines to Bogota	Oct. 21, 1899 ...	...
Communication with interior of Colombia, excepting Amalfi, Ambalema, Buga, Cartago, Ibagua, Manizales, Medellin, Palmire, Pasto, Popoyans, Reimedos, Sonson, and Santo Domingo... ...	Nov. 6, 1899 ...	...
Communication with Valentia (Venezuela)	Nov. 18, 1899 ...	...
Saigon-Bangkok	Nov. 23, 1899 ...	Nov. 25, 1899
Majunga-Tananarive	Nov. 25, 1899 ...	...

The Telephone Service.—The Hammersmith Vestry has been considering plans with notices and schedules in connection with the proposal of the Post Office authorities to break up the roadways and footways in various thoroughfares in the parish for the purpose of laying conduits with multiple ducts, or cast-iron pipes, also for the provision of manholes, &c., for the new telephone system for London, which the Postmaster-General has undertaken to provide. It was agreed that permission be given upon certain conditions as approved by the Vestry.

Wireless Telegraphy.—It is stated by an evening paper that the staff of H.M.S. *Vernon*, at Portsmouth, are engaged on experiments which it is understood will, if successful, precede the introduction into the British Navy of wireless telegraphy for signalling purposes. A torpedo gunboat is to be sent to sea with instructions to keep in touch with a receiving station established on the battleship *Hector*.

The Vulnerability of Cables in War Time.—A correspondence on the above subject between the Marquis of Tweeddale and Sir Edward Sassoon has been going on in the *Times*, and as it may be of interest to our readers, we produce here the two last letters which have appeared.

Referring to Sir Edward Sassoon's letter which appeared in your issue of the 18th, permit me to point out that I never made the statement he ascribes to me—namely, "that the Cuban telegraph cables were not interfered with during the Spanish-American war." My statement to the Chancellor of the Exchequer was that "cable communication with Cuba was maintained up to the last few days of the war," and at the half-yearly meeting of the Eastern Extension Company that "as a matter of fact the interruption of cable communication between Cuba and the United States was never effected." These statements were made by me on the strength of the seventh paragraph in the report of the Cuba Submarine Telegraph Company, dated November 9th, which contained the following passage:—"Notwithstanding these interruptions, the directors are glad to state that through communication has been continuously maintained, the staff remaining at their posts under very trying circumstances."

Sir Edward will, I feel sure, admit that my "persistence" was not altogether without warrant. TWEEDDALE.

I have just read Lord Tweeddale's letter. There appears to exist some mental confusion, to remove which I beg the further hospitality of your columns. In criticising Sir C. Dilke's remark that the experience of the

Spanish-American war has confirmed what all military and naval authorities had already made up their minds to—viz., "that all telegraphic communication is likely to be destroyed in time of war," Lord Tweeddale said, "But the recent war afforded no such experience." Immediately afterwards he went on to say, "It is true that the cable between Hong Kong and Manila was interrupted." He might have added that the American Admiral cut the cables between Manila and Iloilo on May 23rd, 1898.

The Hong Kong and Manila cable, which was laid some 20 years ago and has not been duplicated, is the only cable to the Philippines, and it was cut by Admiral Dewey on May 2nd, 1898. This surely does afford one "such experience"!

As regards the Cuban cables, I have not in any of my speeches or letters asserted that all cable communication between Cuba and the rest of the world was interrupted, but I gave chapter and verse concerning the cutting of the two important Cuban cables as proof that wires "are likely to be, and can easily be, severed in time of war." I quite admit that although in the case of Manila "all" communication was sundered, in Cuba this was not the case; but, Sir, in addition to the typical incident which I cited, there is the cable between Santiago and Guantanamo, which was cut by the U.S. steamer *St. Louis* on May 18th. Then the Jucaro to Tunas cable was cut by the U.S. steamer *Wilmington* on July 21st, 1898. Another instance is that reported in the Press at the time concerning the French cable between Guantanamo and Hayti as having been cut and buoyed by Rear-Admiral Sampson early in June, 1898, and afterwards restored by him, probably to avoid international complications. Then the severing of "all" cable communication between Cuba and the rest of the world, it should be remembered, would have entailed cutting the English cable to Jamaica and the French cable to Hayti—the Key West cable being in the hands of the Americans. That these international cables were not cut was doubtless due to what you, Sir, at the time aptly termed "a tenderness for the rights of neutrals." Lord Tweeddale would fain have it that the whole point at issue should turn on the word "all," which appears to me a narrow way of treating the general question of the vulnerability of cables in war time.

When addressing the Folkestone Chamber of Commerce on the 7th inst. I observed, "How critical the state of affairs is in South Africa it is needless to say, and yet, just when most required, the cable from Delagoa Bay to Mozambique—the solitary cable—breaks down, and we must now rely for news of the most vital importance upon the long landline which runs through Natal to Cape Town." Commenting on this remark, Lord Tweeddale, addressing his shareholders on the following day, said:—"I judge that the lecturer meant to convey the impression that we are cut off from the Transvaal and Natal because the cables are interrupted—that is the only interpretation that can be put upon it."

Sir, I leave the fairness of this construction to all dispassionate and fair-minded readers, and can only say that his multifarious occupations must have prevented Lord Tweeddale from reading the address which he did me the honour to criticise. It is obvious that my protest was directed to the fact that this 25-year old cable had not been duplicated by its proprietors, who had received £1,300,000 in State subsidies, and there is not the shadow of a shade of suggestion that we were entirely cut off from receiving news from the Transvaal and Natal by the long land route. I am glad that the disabled cable has now at last been repaired.

EDWARD SASSOON.

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—December 4th. The Vestry wants tenders for arc lamps and posts. See "Official Notices" November 17th.

Birkenhead.—December 12th. The Corporation wants tenders for the supply of condensing plant, overhead crane, and feeder mains for the electric tramway works and scheme. See "Official Notices" December 1st.

Blackburn.—December 23rd. The Corporation wants tenders for overhead trolley line equipment. See "Official Notices" December 1st.

Blackpool.—December 15th. The Corporation wants for the electricity works four boilers and accessorial steam plant; two 600-KW. steam alternators (or one 1,200-KW.), switchboard, mains, transformers, and battery. See "Official Notices" Dec. 1st.

Denmark.—December 28th. The Corporation of Aarhus is inviting tenders for water-tube boiler plant, steam dynamos, switchboard, and accumulators for electricity works. From our "Official Notices," November 3rd, further particulars may be obtained.

Gloucester.—December 28th. The Electricity Committee wants tenders for extension plant including Lancashire boiler, &c., one 300-KW. steam dynamo, switchboard work, condensing plant. See "Official Notices" December 1st.

Hackney.—December 12th. The Vestry Electric Lighting Committee is inviting tenders for refuse destructors to deal with the whole of the refuse of the parish. Specification, &c., may be obtained at the offices of Mr. Robert Hammond, M.Inst.C.E.

Hackney.—January 2nd, 1900. The Vestry wants tenders for the supply of accumulators. See "Official Notices" to-day.

Harrow.—December 4th. The Electric Light and Power Company wants tenders for a 150 KW. steam dynamo and switchboard extension. See "Official Notices" November 17th.

Lambeth.—December 6th. The Vestry is prepared to receive tenders for 25 arc lamps and posts. For particulars, see "Official Notices" November 10th.

Manchester.—December 2nd. The Tramways Committee wants tenders for 5,000 tons of steel girder rails and 250 tons of steel fish-plates. See "Official Notices" November 17th.

Manchester.—December 16th. The Corporation Tramways Committee wants tenders for steel tie-bars, bolts and nuts for permanent way work. See "Official Notices" this week.

The Midland Corporation.—December 18th. From an "Official Notice" Dec. 1st, particulars may be obtained of certain plant and machinery and conductors, for 10,000 B.H.P. output, required for the new power house to be erected by the Midland Electric Corporation for Power Distribution, Limited. There will be 16 water-tube boilers, six sets of Corliss engines and three-phase generators, transformers, switchboards, mains, batteries, &c.

Mistretta (Sicily).—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Palermo, stating that tenders are invited by the Municipality of Mistretta, not later than December 31st next, for the establishment of a service of electric lighting in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Port Alegre.—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Minister at Rio, stating that tenders are invited by the municipality of Porto Alegre, not later than December 31st next, at 1 p.m., for the electric lighting of that town.

Plymouth.— December 8th. The Corporation wants tenders for tramcars, trucks, motors, trolley arms, &c. See "Official Notices" November 17th.

Rathmines and Rathgar.—December 13th. The Council is inviting tenders for additional feeding and distributing mains, including trenching, cables, joint boxes and house services. See "Official Notices" December 1st.

Roumania.—December 8th. The Roumanian State Railway authorities in Bucharest are inviting tenders until December 8th for the supply of 11,320 porcelain insulators and 10 tons of ingot lead.

St. Pancras.—December 12th. The Vestry wants tenders for (*a*) two dry back marine boilers; (*b*) condensing plant, feed water heaters, steam and feed pipes. See "Official Notices" this week.

Trimdon Grange (Durham).—The owners of East Hetton Trimdon and Trimdon Grange Collieries want tenders for 12 months supply of iron and steel castings, gas and steam piping, and a variety of other sundries including electric light fittings. Specifications from the Storekeeper, Trimdon Grange Colliery Company.

Weybridge.—December 4th. The Oatlands Park Hotel Company, Limited, wants tenders for wiring and fittings for 423 lamps at their hotel. See "Official Notices" December 1st.

York.—December 4th. The Corporation invites tenders for the electric wiring and fitting of the Guildhall, municipal offices and Mansion House. See two "Official Notices" December 1st.

CLOSED.

Hammersmith.—The name of Allen & Co. given as tenderers last week for electric wiring at Hammersmith should read E. P. Allam & Co.

France.—The French Posts and Telegraph authorities have placed a contract for 10 kilometres of iron pipes, 80 mm. diameter, for pneumatic pipe lines with La Société Française pour La Fabrication des Tubes, of Louvroil, at 7 francs 95 cents per metre.

Leeds.—The City Council has accepted the tender of Messrs. Schofield, Son & Co. for buildings, amounting to £2,298; that of the British Insulated Wire Company for cables, at £17,310, and laying *pro rata*; and that of the British Electrical Company for transformers and electrical equipment, at £5,734. These contracts are in connection with the extensions to which we recently referred.

Maidstone.—The following tenders have been accepted by the Corporation for electric lighting, subject to the sanction of the Local Government Board:—

		£	s.	d.
Section	A.—Steam dynamos: Messrs. Thomas Parker, Limited ..	4,318	0	0
"	B.—Boilers: Messrs. Davey, Paxman & Co.	1,318	0	0
"	C.—Condensers: Messrs. Mirrlees Watson and Yaryan Company	883	0	0
"	D.—Switchboards: James White, Glasgow	808	0	0
"	E.—Accumulators: Not decided.			
"	F.—Travelling crane: Messrs. Carrick & Ritchie	245	0	0
"	G.—Mains: Messrs. Callender's Cable and Construction Company	4,128	0	0
"	H.—Arc Lighting: Messrs. Callender's Cable and Construction Company	851	0	0
"	I.—Electricity meters: Messrs. The General Electric Company	530	5	0

Newington.—The Vestry has accepted the tender of Messrs. Johnson & Phillips for supplying and erecting engine, generator, and continuous current transformers for £5,030.

Poplar.—The following contracts have been placed for the engineering works now being carried out for the Poplar Union to Mr. Warden-Stevens' specifications:—

		£	s.	d.
Section	H.—Two Lancashire boilers: Tinkers, Limited	945	0	0
"	K.—Water pressure drums and tanks: John Fraser & Sons	1,256	0	0
"	L.—Steam jet plant.—Three ejector condensers, two steam jet pumps, two injectors: Korting Bros.	112	10	0
"	M.—Auxiliary pumping plant.—One steam air compressor, (direct acting), one three-throw feed pump, one air compressor (three-throw), two centrifugal pumps, one three-throw hot water pump: Clay, Henriques Co.	281	10	0

The list of contracts previously placed are:—

	£	s.	d.
Section A.—Two steam turbines and dynamos, direct coupled: Greenwood & Batley	630	0	0
„ B.—Electric motors.—One 12-B.H.P., one 8-B.H.P: General Electric Company	231	0	0
„ C.—Battery of accumulators, maintenance for eight years at £22 per annum: Hart Accumulator Company	456	8	8
„ D.—Electric wiring and fittings: Speedy, Eynon & Co.	1,975	0	0
„ E.—Main switchboard and distribution boards: Veritys, Limited	523	0	0
„ F.—Engine and dynamo (enclosed high speed): Thames Ironworks Company	827	0	0
„ G.—Electric motors.—One enclosed 14 B.H.P., one partially enclosed 20-B.H.P., one partially enclosed 7-B.H.P.: Fuller-Wenstrom Manufacturing Company	419	0	0
„ J.—Economiser: James Carter & Sons.	99	10	0
Deep wells and pumping machinery; Harvey & Williams, Limited	1,600	0	0

FORTHCOMING EVENTS.

Tuesday, December 5th.—At 8 p.m. Northern Society of Electrical Engineers, Grand Hotel, Aytoun Street, Manchester. Paper on "Methods of Suppressing Arcing at Switch and Fuse Contacts," by E. K. Scott.

At 8 p.m.—The Institution of Civil Engineers. Papers to be further discussed:—"The Waterloo and City Railway, and its Electrical Equipment," by Messrs. Dalrymple-Hay and Jenkin; "Combined Refuse-Destructors and Power Plants," by C. Newton Russell, A.M.I.C.E.

Wednesday, December 6th.—Institution of Electrical Engineers' annual dinner, Grand Hall, Hotel Cecil.

Thursday December 7th.—At 8 p.m. The Institution of Electrical Engineers. "The Cost of Steam Raising," by John Holliday, A.M.I.C.E.; "Influence of Cheap Fuels on the Cost of Electrical Energy," by R. E. Crompton, Past President (adjourned discussion).

Friday, December 8th.—At 2.30 p.m. Institution of Civil Engineers. Students' visit to the works of the Baker Street-Waterloo Railway.

At 5 p.m.—Physical Society meeting in the physical laboratory of the City and Guilds' Technical College, Leonard Street, Finsbury. "Cylindrical Lenses," by Prof. Silvanus Thompson, F.R.S.; "Exact Formulæ for Lenses," by Mr. T. H. Blakesley; "On an Organic Compound of great Double-Refraction," by Prof. Silvanus Thompson, F.R.S.

At 8 p.m.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W. "A Continuous Mean-pressure Indicator for Steam Engines," by Prof. W. Ripper.

NOTES.

Trades Union Tyranny.—We have just had brought to our notice the case of a man who has been deprived of nearly half his wages by the tyranny of a Trades Union. He was found capable, though only a labourer nominally, of doing certain work better than other men who were styled fitters. He was, therefore, put on to this work and paid 9d. per hour—a rate higher than the Union rate in the particular locality. When the Union heard of it, they complained, and to avoid a strike the man had to be put off, and set back to his old work and pay at 5d. per hour only. If he has sense, he will probably obtain a certificate from his employers and proceed to America and obtain the rate of pay for the work he has been proved capable of performing. In the meantime, our workshops are behind time for lack of labour of every kind, except the worthless product of the far too numerous incapables who seem to be so prominent when a sober labourer has to be crushed.

Acetylene Lighting of a Town.—Tata Tovaros, Hungary, is the first town to have the distinction of inaugurating a public lighting system of acetylene gas. One of the most notable features about the system apparently is the small space taken up by the generating plant, and though it is proposed to do a considerable amount of public lighting, in addition to house lighting, only two men are required to operate the whole of the plant. The pipe system is laid as for an ordinary gas supply system, and no special precautions are apparently necessary at joints. Curiously enough, there are no local electricity works capable of producing calcium carbide, and this has to be obtained either from France or Switzerland.

Hammersmith Extensions.—Since we described these works, some few months ago, additions have been made to the plant in the shape of a new 300 KW. alternator of the Ferranti type, coupled to a Robey engine. This brings the plant up to three 125-KW. and three 300-KW. machines. We have often pointed out in these columns the importance of anticipating the demand for lighting; it may be difficult to forecast, and it wants a certain amount of courage to propose a scheme involving considerable outlay, but judging by the condition of most of the metropolitan and suburban lighting systems, it is quite apparent that the demand for electric lighting has been underrated. At Hammersmith it is proposed to lay down plant which will meet all possible requirements for the next two or three years. In order to do this, extensive additions to the existing buildings are being erected, which comprise a large boiler house capable of taking three 500-H.P. boilers, and an engine house, which is a great deal larger than the present one, and will afford accommodation for three 600-KW. sets. The end of the engine house is permanently raised, and is on a level with the street, and this will give great facilities when it is necessary to bring in the plant. There is on order at the present moment, under the extension scheme, two 600-KW. plants, which will consist of Robey engines and Siemens alternators. The main principles of these engines will be similar to the 300 KW. sets, which we have previously described. Three water-tube boilers are being put up, each of which will have a capacity of 500 H.P. Some notable changes are to be introduced in the price of current, and the charge will be based on 6d. per unit for the first hour and 3d. afterwards, this being a considerable reduction on the former method of 6d. for the first two hours and 4d. afterwards. The lighting authorities of Hammersmith are especially fortunate in having ample room for extensions, and we suppose there is hardly a station in the vicinity of London which is better provided for in this respect. Unlike many other alternating current systems, distinct encouragement is given to the use of motors on the circuits, and at the present moment there is an aggregate of 50 H.P. made up of small motors. This branch of supply has been so satisfactory that it is fully expected there will be considerable accession to the present motor load.

The Institution of Electrical Engineers at the Paris Exhibition.—It is proposed to hold a meeting of the Institution of Electrical Engineers in Paris immediately before the opening of the International Electrical Congress, and probably on August 16th, or 16th and 17th, 1900. It is further hoped that a joint meeting with the American Institute of Electrical Engineers may be arranged at that time. In order that a preliminary estimate may be formed of the number of members of all classes who will take part, the Council would be glad to receive at an early date the names of those who think it likely that they may attend.

The Cost of Electric Haulage in Mining.—The difficulty of obtaining precise data as to the economy effected by electric driving in mining work, is as great as it is in other industrial operations. It is, however, possible to obtain isolated instances which show how great the saving may be when electricity is substituted for ordinary methods of haulage. The Berwind-White Coal Mining Company, at Windber-Pa., who are the owners of extensive mines in the district which produces high grade fuel, some time ago adopted in place of the ordinary methods of haulage, electric locomotives, of the Baldwin-Westinghouse type. One mine, in particular, was formerly worked by mule haulage, combined with an ordinary rope hoist in the main heading, having a dip of 2½ per cent. over a length of some 3,000 feet. Under the old *régime*, with eight mules and eight drivers, in addition to the hoist, the output of coal per day was 200 tons, which cost to raise over £4, or 5d. per ton. Substituting, however, one Baldwin-Westinghouse locomotive, weighing about 26,000 lbs., and abandoning the hoist and mules, the output of coal was increased to 480 tons of coal, as well as a good deal of rock, and the cost per ton was actually reduced to ½d. per ton. This is a significant instance of what electricity will do under some conditions.

The Civil Engineers' Presidential Address.—The recent initial address of the new president, Sir Douglas Fox, contains very little pertaining to electrical engineering, and generally the address was an example of the difficulty which every president must feel in preparing anything much more than a series of historical statements and comparisons. Telephone practice, we are informed, is much behind that of other countries, and, we would add, is likely to be while present exorbitant charges and indifferent service are maintained; and he foreshadows more metallic returns and automatic exchanges, and more numerous trunks, as well as proper subways for these and other mains, not omitting, we may hope, traction mains when the London County Council wakes up. Electric buried railways are not keeping pace with increase of population and traffic owing to difficulty in raising capital. The backward condition of both electric light and traction is attributed to the obstruction of vested interests and of county, district, and even parish councils. Reference is made to the fact that in New York and Brooklyn—cities of a combined population about one-third that of London—about 880 millions of people are carried annually, and decreases are only found on the non-electric overhead railways. The above is practically all that the president of the Institution of Civil Engineers could find to say on electricity and its applications. This is not his fault, but the fault of others. We omitted above any reference to one of his expressed hopes, namely, that the conduit system may be proved in the near future to be capable of being brought into practical and economical use. Clearly Sir Douglas is of opinion that what he calls the unsightly overhead system is at present the one which is practical; and we may venture to think that so practical an engineer as Sir Douglas would not have committed himself to the task of putting back the hands of the clock for London traction so many years in order to load the overburdened ratepayers with a system that he could only hope would some day be capable of being brought to a successful issue. The overhead system is successful. It may not be so nice as a successful conduit would be, but it would enable five to six million of Londoners to travel, and would put a stop on the overbearing insolence of the steam railway companies, which have been given longer life by a pseudo-socialistic County Council.

Gas-Driven Electricity Works.—Notwithstanding the theoretical advantages that would seem to be gained by the use of gas engines for electric lighting, it cannot be said that they are making much headway as regards public works. One of the most important examples in this country of gas engines for dynamo driving is that of Leyton; and though we have no authentic details as to the manner in which the plant has performed, we do not think there is any immediate likelihood of the gas engine principle being extended. Yet it must not be forgotten that the cost of fuel at Leyton per unit is one of the lowest in London. If, however, there is not any marked tendency on the part of public lighting works to adopt gas engines, it must not be overlooked that for private work they are being adopted on a somewhat large scale. Indeed, we think we are not incorrect in stating that at the famous works of the Brunner-Mond Company, gas engines of 1,000 H.P. each are being erected to drive dynamo electrical machinery; and there is an additional interest in this installation because producer gas is to be employed. One of our American contemporaries recently published a short account of an interesting gas-driven station in the town of Oerlikon; and though this instance may be familiar to some of our readers, it is worth repeating that the installation at present includes one gas-driven engine of 200 H.P., and two of 100 H.P. The current from these works is utilised for the purpose of a local tramway service. A producer gas is employed which is washed and passed through coke scrubbers and sawdust, and apparently there is no noticeable smell. The gas engines and the generators have been made by the Machinen Fabrik Deutz, the dynamos being compound four-pole continuous current machines, which generate current at 500 volts when running at 130 revolutions per minute. A battery of 280 Tudor cells is connected in parallel to the dynamos, the regulating cells being charged by a motor generator. It is stated that the coal consumption per effective horse-power is 1·4 lbs., and the cost of operating the electric line per car-mile is given as 34·6 centimes.

Coal Smoke Abatement.—We were obliged some twelve months ago to pass some strictures on the well-meaning efforts of Sir W. B. Richmond and a few other busybodies, who had taken on themselves the task of getting up prosecutions for smoke abatement. It now appears from another letter in the *Times*, following just about a year after that on which we commented, that the self-constituted society made, by means of one inspector, 1,000 observations in six parishes. They reported 530 nuisances and persuaded the Vestries to prosecute in 60 cases. They are now asking the general public to subscribe in order to secure an annual income. So far all efforts appear to have been confined to the West End, where dwell chiefly, one may suppose, the various titled and other members. The *Times* devotes a leading article to the subject, wherein some doubt is thrown on the wisdom of a committee whose zeal possibly has outrun its discretion. If some people had their way there would be no sort of manufacture possible in this country. Sir William's committee calmly intermeddle in a question of technical chemistry of great difficulty, and can do little except by the brutal method of prosecution. Smoke is a nuisance, and no one wishes it to continue, but the fires of West End drawing rooms make more smoke in the aggregate, and of a less pleasant type, than do West End manufactories. We hold that smoke inspectors ought to be duly qualified experts, able to know if the steps taken to reduce smoke are really correct. Smoke can be prevented in very many cases, but we repeat that it is the domestic fire that is the chief offender.

The Traction Experiments on the Underground Railway.—Although we do not think it the intention of either the consulting engineers or the contractors to make a secret of what is being done at the present moment on the Underground Railway in the shape of traction experiments, there has been for some reason or other a certain amount of mystery shrouding the important work that is being carried on. Travellers of an observant nature must have, for some months past, noticed the four additional rails that are to do duty as conductors for the double track between Earl's Court and High Street, Kensington, stations. To avoid, as far as possible, disturbance of the track, it has been necessary to use separate conductors for the out-going and return current; these consist of heavy channel iron rails, supported on porcelain insulators, of somewhat heavy character. Armoured cables are carried in trenches underneath the rails, and make connection at different points with the channel iron conductors. At crossings the rail is broken, and we presume connection is made underneath the rails. A temporary power house has been erected some few yards away from the platforms of the Earl's Court stations, but the entire plant is not of very considerable dimensions. Some days ago the first trial trip was made, and as far as we can ascertain, the experiment was a pronounced success. We believe, at any rate, that many of the railway officials are inclined to be enthusiastic with the results.

Give It Up?—A contemporary is responsible for the following conundrum, picked up in the tea-room of the Institution by Meteor, after the presidential address. The riddle may be propounded thus: Meteor affirms that Phodyne imagines that A declares that B denies that C asserts that D is a liar. A speaks truth once in three times, B, twice out of five times, and C three times in seven. What price D's veracity? Phodyne's specific veracity may be measured by the statement of Meteor that Phodyne says the problem is easy. Meteor's veracity is, then, the only doubtful factor in the problem. Meteor thinks the question indeterminate, owing to the variety of solutions. That's the worst of those tea-rooms!

Appointments Vacant.—The Llandudno Council wants an assistant electrical engineer for the electricity works. The Rochdale Workhouse authorities want a clerk of works (afterwards engineer-in-charge) for electric lighting plant. See "Official Notices" this week.

The Eccles Corporation invites applications for the appointment of borough electrical engineer at £200 per annum. See "Official Notices" this week.

The Effect of Thames Water in Boilers.—Mr. C. E. Stromeyer, the chief engineer of the Manchester Steam Users' Association, writes to a contemporary saying that last year the long-continued drought was the cause of many boiler furnace collapses, as many of the feed-water supplies had become heavily charged with mineral salts. He adds:—

> According to recent information, a somewhat similar experience is being passed through by those London steam users who draw their feed water from the river Thames, and I would strongly urge them to have their boiler water tested daily with a salinometer; or, better still, they should use town's water.
>
> Formerly the drinking water which was taken from the Thames and its London tributaries, after being contaminated with sewage, but not with sea water, was again discharged into the river, not much below London, and thus kept back the sea water. Now that the sewage is being carried further away it mixes at once with sea water, and does not exert the same influence as before. As a consequence, the Thames water, even above London, is much more brackish than formerly, and boilers which for years past have been fed with Thames water without giving trouble, are all of a sudden suffering from collapsed furnaces and excessive corrosion traceable to an excess of sea salts in the water.

The American Mechanicals.—Next week, from 5th to 8th inst., the American Society of Mechanical Engineers holds its convention in New York City. Admiral G. W. Melville will deliver his presidential address. Among the papers to be read are the following:—

"The Steam Engine at the end of the Nineteenth Century," by R. H. Thurston.
"New Graphic Method of Constructing the Entropy-Temperature Diagram of a Gas or Oil Engine," by H. T. Eddy.
"Education of Machinists, Foremen, and Mechanical Engineers," by M. P. Higgins.
"Friction of Steam Packings," by C. H. Benjamin.
"Note on Fly-wheel Design," by A. J. Frith.
"A Broken Fly-wheel, and how it was Repaired," by James McBride.
"Efficiency Test of a 125-H.P. Gas Engine," by C. H. Robertson.
"The Southern Terminal at Boston," by H. J. Conant.
"The Value of a Horse-power," by G. I. Rockwood.

Personal.—At a meeting of the Bradford Corporation Electricity Committee last Friday it was decided to appoint Mr. Gibbings, the present engineer, as consultative electrical engineer at a salary of £350 a year, and to advertise for a manager at £350 a year. This action has been taken to meet the wishes of Mr. Gibbings, who has an important consultative practice.

The staff of the Wakefield Corporation Electricity Department recently presented Mr. J. K. Brydges, chief engineer, with a silver mounted dinner gong, on the occasion of his leaving Wakefield to take up an appointment at Eastbourne.

Mr. J. F. Taylor, manager of the Hartlepool Electric Tramways Company, was lately presented with a silver card salver, and Mrs. Taylor with a lady's companion, by the staff, on the occasion of Mr. Taylor's appointment as general manager of the Madras Tramways.

The new Tramways Committee of the Corporation of Newcastle-on-Tyne has appointed Mr. A. E. Rossignol, at present under the Corporation of Glasgow, to be resident engineer of the Newcastle tramways. Mr. A. W. Wheildon, engineer-in-chief of various power stations for the British Thomson-Houston Company, was next on the list.

The West Ham Council on Tuesday, the 28th ult., unanimously appointed Mr. James K. Bock borough electrical engineer.

Northern Society of Electrical Engineers.—Members have been invited to send in their nominations for seats on the Council.

The British Association.—The proposal was brought forward at Dover, and has now been urged at the Society of Arts in London, that in 1903 or 1904 the B.A. should hold its meeting at Colombo, Ceylon. We question whether many practical electrical scientists from this side would be able to spare so large a slice out of the year as this would occasion—not that their absence would greatly affect the total number of visitors present!

Cool!—A Liverpool paper says that a trust has been formed of the principal electrical fan makers in the United States. Its joint capital is $25,000,000.

Searchlights for the New York Fire Department.—The New York Fire Department is about to add a complete portable electric searchlight plant to its apparatus. The searchlight wagon will go to fires with the engines, &c., and it is believed it will add greatly to the efficiency of the force, both in saving life and property. A note in the *Scientific American* says that it resembles a fire engine in general appearance, but instead of a pump it has an engine and dynamo. There are two searchlights, each with an 18-inch lens. These will be carried on a platform behind the driver's seat. They can be used either from the platform or removed and carried to any desirable point of vantage, all communication with the generator being kept up by means of flexible cables which are insulated with rubber. The lights are provided with devices for quick regulation, so that the light may be spread out over a wide area or confined and directed to any particular point. The purpose of the apparatus will be to light up dark parts of the street and aid the firemen in laying the hose, setting ladders, &c., also to light up the front of buildings where people may be in danger, and to project light into the buildings themselves. This seems to be a step to which the British fire authorities would do well to devote attention.

The Institution Dinner.—Our readers are reminded that the annual dinner of the Institution of Electrical Engineers will be held at the Hotel Cecil on Wednesday next, December 6th, and that applications for tickets not yet submitted should be sent in at once.

Electricity in Agriculture.—*Commercial Intelligence* quotes from the *Eleckt. Zeits.* that an association of farmers in the district of Ochsenfurt (Bavaria) is erecting large electrical works near the village of Bütthard, in Lower Franconia, which will be entirely devoted to agricultural uses. The current is produced close to the village of Schäftersheim, a distance of 11 kilometres, requiring for its creation a force of about 150 H.P., which is supplied partly by steam and partly by water, and conducted as current of 5,000 volts to the villages of Bütthard, Laudenbach and others, where it finds the most varied use. Movable electromotors for driving thrashing machines, chaff cutters, bruising mills, &c., are supplied, and connecting boards for the conducting wires are placed at every farm. The motors are of very simple construction, and can be easily handled by any of the farm hands. The electric light will be widely used in all the villages named, and on account of greater security with regard to fire in the lighting of agricultural buildings it is daily increasing in use among farmers.

Electric Power for Working Dredges.—We read in the *New Zealand Mines Record* that Messrs. J. Marshall and J. Solomon, who proposes to provide electric power for working dredges in Central Otago, have been circularising the principal dredge owners bringing their scheme to notice. They propose to work the dredges on the Clutha, Kawarau, and Molyneux rivers, and they are seeking support so as to enable the scheme to take practical shape. The circular says:—

> In order that the success of the scheme may be made certain, there are two initial requirements: (1) that the dredges now being built should undertake to avail of the power proposed to be created; and (2) that the projectors of the scheme should be in a position to assure the supply of same when required. These requirements in a measure somewhat hamper the flotation of a company to provide the necessary capital, but the projectors deem it absolutely essential to test the feeling of those likely to avail of the power before committing themselves to any large expense.

The promoters hold the first right to 40 Government heads of water from the Roaring Meg—the finest water-right in New Zealand—taken in at such a point as will furnish 1,200 feet vertical pressure. It is proposed to pipe the water to a site near the foot of the Meg, and there to erect electrical works; thence the power to be distributed by the usual method. Although not in a position to furnish details of cost, or price of power supplied, the promoters are assured that a large reduction can be made on the present expensive system of steam—besides, in the case of new dredges, saving a large initial cost in the way of machinery. They are in communication with electrical engineers, and on receipt of particulars of cost, &c., matters will assume a definite shape.

Gas v. Steam Engines.—The *Mechanical World* quotes the following discussion of the relative economy of the gas and steam engine from a recent trade publication of a large manufacturer of both types. A correct answer to the question, "What is the comparative cost of operating a gas engine and a steam engine of equal power?" is stated to involve a special solution for each individual case. "Considered solely as a machine for converting the total energy of the fuel into mechanical work, the gas engine is by far the more efficient. There are gas engines in operation which transform over 25 per cent. of the heat in the fuel into useful work, while in the very best recorded performance of the steam engine barely 14 per cent. of the energy in the coal burned has been thus accounted for, and in the average steam engine plant it does not exceed 5 per cent. There are many small plants, consisting of common slide-valve engines, with uneconomical types of boilers, in which less than 2 per cent. of the energy in the coal burned is converted into mechanical work. At the same time it must be remembered that a given number of heat units in the form of fuel suitable for use in a gas engine costs more than an equal number in the shape of coal or other ordinary fuel suitable for burning in a common boiler furnace. As a general proposition it may be assumed that in a plant which operates continuously, the item of fuel alone will be somewhat greater for the gas engine than for an approved type of modern steam engine, except possibly in the case of an engine running on producer gas. Where the service is of an intermittent nature, or the power is required only for a comparatively short time each day, this difference in favour of the steam engine becomes less, and may even become a balance in favour of the gas engine, for the reason that in the gas engine plant there are no 'stand-by losses'—*i.e.*, radiation and leakage when standing idle under full steam pressure, and coal burned in banking fires and raising steam. With the gas engine the fuel expense starts and stops with the engine. But the fuel cost is only one item in the cost of producing power. One must consider the value of the additional space and buildings required for a boiler plant; the cost of a stack; labour of handling coal and ashes; cost of attendance, oil, and water; depreciation, repairs, and insurance on a boiler plant. The gas engine has a field of its own which cannot be occupied by the steam engine, and there is no immediate prospect of the gas engine seriously encroaching on the legitimate field of the steam engine." Some important considerations are here set forth very clearly and concisely.

Electric Shock Fatality.—At Messrs. Isaac Holden and Sons' Alston Works, Bradford, on Monday, last week, Edward Driver, aged 22, employed by Messrs. Collinson Bros., electricians, Aldermanbury, Bradford, was accidentally killed. The firm were fitting up a new electric installation at Messrs. Holden's, and Driver while at work on a trestle missed his footing. To save himself he seized portion of a large electric arc lamp. At the same time he apparently made a "contact" with his feet on an iron grating, and the shock which he received instantly killed him. At the inquest on Wednesday, Dr. Lodge said there was a discoloration of the right hand, but no burning. He had not known of such a case before. Mr. Gibbings, electrical engineer to the Bradford Corporation, said the highest voltage that the deceased could have received was 225, whereas, according to the Board of Trade, 500 was considered low and not dangerous. Persons had been known to receive 2,500 voltage without a fatal result, but in electricity there were latent powers concerning which they knew little. In this case the deceased's wet boots and freely perspiring body led to his being in a favourable condition for a severe shock. A verdict of "Accidental death" was returned.

The War.—Messrs. Raphael Tuck & Sons, Limited, are publishing a photogravure, after the original painting by Harry Payne, of "Sons of the Empire," for the benefit of the Mansion House Transvaal War Fund for Widows and Orphans, at prices ranging from 5s. to £5 5s. each. The entire profits on the first year's sales will be placed to the fund. The list is dedicated (by permission) to Field Marshal the Right Hon. Viscount Wolseley.

NEW COMPANIES REGISTERED.

Garston and District Tramways Company, Limited (64,238).—This company was registered on November 21st, with a capital of £5,000 in £1 shares, to apply for any Acts of Parliament, provisional orders of the Board of Trade, or other authority for the construction, maintenance, and working, with or without the use of steam, electricity, or other power, of any tramways, and to carry on the business of tramway proprietors, electricians, electrical and general engineers, manufacturers of wires, cables, lines, &c. The first subscribers (each with one share) are:—Jacob Atherton, Hurst House, Huyton, Lancs., manufacturer; George H. Nesbitt, Ashfield, Huyton, Lancs., electrical engineer; Albert E. Haptie, 5, Darham Road, Seaforth, near Liverpool, manager; Charles O. Grindrod, 11, Knowsley Road, Rock Ferry, Cheshire, gentleman; Frederick W Lintern, 22, Beaumont Street, Liverpool, book-keeper; Allen Buckley, 8, York Road, Seacombe, Cheshire, book-keeper; and H. Russell, 25, Demesne Street, Seacombe, Cheshire, book-keeper. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, £200; remuneration as fixed by the company.

English Electric Manufacturing Company, Limited (64,247).—This company was registered on November 21st, with a capital of £385,000 in £5 shares (37,000 preference), to carry on the business of electrical and mechanical engineers, electricians, generators, distributors, and suppliers of electricity for the purposes of light, heat and motive power, manufacturers of electrical apparatus and machinery, &c. The first subscribers (each with one share) are:—Richard H. Prestwich, 13, Marsden Square, Manchester, cotton spinner; B. Sykes, 33, Winckley Square, Preston; T. D. Lingard, 10, Booth Street, Piccadilly, Manchester, solicitor; S. H. Short, 110, Cannon Street, E.C., electrical engineer; T. S. Turnbull, 13, Spring Gardens, Manchester, solicitor; G. Flett, 110, Cannon Street, E.C., contractor; and F. O. Mott, 110, Cannon Street, E.C., clerk. The number of directors is not to be less than three nor more than seven. The first are George Flett, John Kerr, Thomas D. Lingard, Richard H. Prestwich, George Richardson, and Sidney H. Short; qualification, £1,000; remuneration, £1,250 per annum, divisible. Registered office, 13, Spring Gardens, Manchester.

SUPPLY STATION ACCOUNTS.

The Accounts of the Cheltenham Corporation.
Public lighting and private supply.

Electricity supply undertaking shows a slightly better state of affairs than in 1897, but there is still a loss on the year's working of over £1,000 after allowing for interest and sinking fund. The gross profit was over £2,100, but the sinking fund and interest payments amounted to £3,700 odd, showing a difference of over £1,100 as compared with £1,400 the previous year. The gross profit in 1897 was £1,200, and the sinking fund and interest taken together over £2,600. Thus the net loss is less by £300, the difference between an increase of £900 in gross profit and of £600 in repayments, &c.

General Statement.

	1897.	1898.	Increase.
Total capital expenditure ...	£55,691	£75,125	£19,434
Number of units sold	248,516	375,834	127,318
Number of lamps connected ...	16,140	19,000	2,860
Gross revenue	£4,010	£6,113	£2,103
Gross profit	£1,262	£2,148	£886
Average price per unit sold ...	3·84d.	3·83d.	−·01d.

The sales of current is spread over 302 consumers, while the public lighting is represented by 134 arc lamps and 13 incandescent lamps. The maximum demanded supply was 360 kw. The proportion of units is shown below:—

Units generated.	Units to street lamps.	Units to private supply.
507,830	192,712	183,122

The price per unit sold has remained practically unaltered; a slight increase is due to the greater number of sundry goods sold.

Revenue Statement.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current ..	£3,978	3·84d.	£6,007	3·83d.	−·01d.
Meter rents	2	·001.	2	·00d.	·00d.
Supply of sundry goods	30	·031.	104	·07d.	+·04d.
Sundry	...	...	...	...	...
Gross revenue	£4,010	3·87d.	£6,113	3·90d.	+·03d.

The figures certainly indicate that the price charged for street lighting is abnormally low. The receipts per unit under this head amount to about 2¾d., or only about ¼d. over total works' cost. The private supply charges are 6d., 5d., 4d., and 3d., and out of a total of over £4,000 (excluding rebates) over £3,500 is obtained from the 6d. units. It is evident, therefore, that as more than half the units sold are taken by the public lighting, the loss in working is really due to the low price fixed for the street lighting.

We now turn to the costs of production. These are very moderate indeed. For a town of the size and situation of Cheltenham a works' cost of just over 2d. may be regarded as satisfactory. Coal and fuel shows an increase of nearly the fifth of a 1d., due probably to the enhanced cost of coal all over the country. Works' costs, however, have slightly fallen, and total costs have gone down by about the eighth of a 1d.

Cost of Production.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£704	·68d.	£1,322	·84d.	+·16d.
Oil, waste, water, and engine room stores.	185	·18d.	269	·17d.	−·01d.
Salaries and wages incurred in generation and distribution.	1,136	1·10d.	1,316	·84d.	−·26d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	280	·27d.	528	·34d.	+·07d.
Works' cost	£2,305	2·23d.	£3,435	2·19d.	−·04d.
Rent, rates and taxes	93	·09d.	152	·10d.	+·01d.
Management and expenses, salaries of managing engineer, secretary, clerks, &c.	208	·20d.	236	·15d.	−·05d.
General establishment charges, stationery and printing, law charges and insurance	142	·14d.	142	·09d.	−·05d.
Other expenses	...	...	...	...	...
Total costs	£2,748	2·66d.	£3,965	2·53d.	−·13d.

Profit Statement.

	1897.	1898.
Interest on loans	£1,074	£1,650
Sinking fund for repayments	1,606	1,617
Net profit carried forward	−1,418	−1,119
Gross profit	£1,262	£2,148

CITY NOTES.

Aron Electricity Meter, Limited.

The report of the directors reads:—"The directors have the pleasure to submit the first accounts of the company, duly audited, for the term of one year and nine months ending September 30th, 1899. The balance to credit of profit and loss amounts to £26,107 9s. 2d., out of which the sum of £9,829 19s. 5d. (less £2,316 1s. 11d. cost of establishing the Schweidnitz Factory), amounting to £7,513 17s. 6d., representing the net profit for the nine months prior to the formation of the company, will be put to a reserve account. This leaves a balance of £16,277 9s. 9d., out of which the interim dividend on the preference shares was paid, amounting to £2,509 18s. 8d., leaving the sum of £13,767 11s. 1d. The directors are much encouraged by the result of their work, as shown in the profit and loss account of the last nine months, the period during which they have been in actual charge of the company. The small decrease of profits during the first part of 1898 is explained principally by the necessity of having had to change over from the supply of the old type to the new type meter, which caused a temporary decrease in sales. The directors propose to deal with the available profits as follows:—To pay a dividend at the rate of 6 per cent. per annum on the preference shares for the six months ending September 30th, 1899, absorbing £3,750; and further, to pay a dividend at the rate of 6 per cent. per annum for the year ending September 30th last on the ordinary shares, absorbing £7,500, leaving a balance to be put to reserve of £2,517 11s. 1d. The prospects of the company's business are very bright, and the meter is gaining in favour both in Great Britain and on the Continent. To meet this growing demand, steps are being taken by the board to considerably increase the output of the factories. The directors' anticipations as to the value of patents in foreign countries have so far been realized, that they have effected the sale of the American patents on satisfactory terms. The London Stock Exchange require alteration in Section 78 of the Articles of Association, and a resolution will be submitted to give effect to this. Messrs. Price, Waterhouse & Co., who have acted hitherto as auditors of the company, offer themselves for election."

Sir James Pender, Bart., M.P., presided on Thursday last week at Winchester House, over the second ordinary general meeting of the shareholders of the above company.

In moving the adoption of the report, the Chairman said that it required a few words of comment on his part, because it was the first meeting they had had since the formation of the company, and the accounts covered a period of 21 months. He thought they had every reason to congratulate themselves on the result of the working of the business up to date. In the prospectus the statement was made that the highest profits ever made by the company were in 1897, and they were given as £18,550, exclusive of any allowance to Dr. Aron. In dealing with the profit and loss account of 1898, the profit was nearly at the same rate, viz., £17,731, and the slight check to the business was easily accounted for by the charges which necessarily had to occur with the transference of the business from a private concern to a company. Another fact was that up to the beginning of 1898, the bulk of the profits derived by Dr. Aron were made out of the old type clockwork meter, and when the new type meter was brought to the front, Continental engineers suddenly stopped ordering the old type meter in large quantities, and gave orders for samples of the new type, and that for some time caused a decrease in the returns of the German business, which the rapid increase in the English and Austrian business could not quite balance. With regard to the profit and loss account for the past nine months, during which period the directors had been responsible for the working of the business, it proved the business to be an unqualified success. They had, in those nine months, made a trade profit of £18,391, which practically meant an increase of 25 per cent. on the very best year mentioned in the prospectus, and this profit would probably have been much greater but for some difficulties which they had encountered. To meet the growing demand for the new type meter they had had to considerably increase their staff and tools and stock. Their efforts had been so far successful, as was proved by the figures of the past few months. But the coming year would, of course, reap the bulk of the benefit of this re-organisation. He was glad to say that at the present moment the rate of taking orders was progressing from month to month, and they had not lost a single central station that had taken their meters, while they were getting new ones every day from every part of Europe. Owing to the arrangements they had made, in the next 12 months they would not only be able to cope with new orders, but also to execute orders in arrears. It would be seen by the accounts that a good sum had been placed to reserve, and further, they would see that arrangements had been made for the sale of the American patents, which would increase their assets by about £9,000 in cash and £33,000 in shares. They considered the business in America to be important, not only on account of the profit-earning capacity there, but also on account of the novel effect which it would have in their favour if they competed successfully with the present American meters in their own home. It was hoped that they would be equally successful in due course in disposing of their patents in other countries, and thus create a large reserve, without unduly trenching on their trading profits.

Mr. R. W. Wallace, Q.C., seconded the resolution, and in doing so, said that very often difficulties arose in the formation of companies by the exaggerated statements of the vendors, but in the case of that company they had met with unqualified support from Dr. Aron and Mr. Guthrie and the statements these gentlemen had made were not exaggerated in the slightest degree. Dr. Aron was not neglecting the business now he had sold it, but with his great intelligence and skill was endeavouring to add to the value of the property. With regard to the question of why they manufactured these things so much abroad, he might say that it was very difficult to get clockwork made in England, and Schwerdmeis was the best seat of manufacture of the particular kind of works they required.

Replying to Mr. Howard, the Chairman said that if the American company was a great success their interest in it would be much more valuable than now appeared. The contract had been actually signed. The board were considering the question of what could be done to work the patent in France.

The motion was then carried, and a dividend at the rate of 6 per cent. on the ordinary shares was agreed to.

An extraordinary meeting was then held to make a slight alteration in the articles of association.

The Blackheath and Greenwich District Electric Light Company, Limited.

The third ordinary general meeting of this company, held at Cannon Street Hotel on Friday last, was presided over by Sir John Wilcox, M.P.

The Chairman said that the document before them covered a period from May 11th, 1896, to September 30th, 1899. That was the period during which the company had been in existence, but the present board had been controlling the company's affairs for little more than a year during that time. They had endeavoured to carry out the Parliamentary rights for Blackheath and Greenwich districts, and he hoped the shareholders would see that they had lost little time in the prosecution of the work. It was not wise to unduly hurry engineering works and cable-laying operations of this kind. They aimed rather at making progress with discretion, and securing a substantial and reliable installation. The expenditure reached an aggregate of £84,000, the great part of which had been expended upon buildings, plant, land, and the works generally, which are now nearly completed. He thought they might claim unprecedented rapidity of work, in that within a year of the beginning of construction work they had actually commenced the supply of current. It had been a borrowed light, and he was afraid, from what they heard, it had not in all respects been as satisfactory as they would wish, but he hoped that the blame of a flickering and unsteady light would not be imputed to the Blackheath and Greenwich Company. It was not their failure, and he hoped their consumers would not judge them by present experience, but

have a little more patience. He thought they would be able to show that they had established a system at once reliable and efficient. He referred at some length to the constitution of the board, and the special qualifications of several of the directors, one being connected with one of the most successful London supply companies, and another, the chairman of a municipal committee, which has the credit of establishing one of the very best and most successful electrical installations within the metropolitan area. Another director had acted with a large West End electricity company, and had had a very large experience in the administrative and practical departments of this business. Those three gentlemen had placed their knowledge freely at the service of the board, and their assistance, support, and guidance had been such as fees could not themselves have secured from practical consulting engineers. He attributed the rapid progress made in the completion of the works to that cause. The works, both as regards productive power of the plant and efficiency of the distributing media of the cables and connecting wires, would be efficient and stable. He could not fix upon a date when the generating station would be in operation. The machinery was, to a large extent, already completed, but some parts had not yet been tried. In a very short time they would be supplying current from their own works. It would be an assurance of substantial and continuing business to know that up to October 31st last practically 7,000 lamps of 8 C.P. had been ordered, and that nearly half that number had actually been connected with the company's mains. Since then there had been a further increase of applications, and the little hesitation that now obtains in the district will at once disappear when possible users discover that they can obtain a good and efficient supply of light. There were several applications for motor power, which promised to be especially advantageous to the company, from the fact that it would give employment to the plant in the day time, when the machinery is not wanted for lighting. In addition to the 40 H.P. applied for, they were negotiating with other applicants representing at least double that amount already. The company was formed for supplying Blackheath and Greenwich, and it was regarded as being of a substantial and hopeful character, but they had since applied to Parliament for an extension of area, with the result that they now had a considerably larger area than they originally possessed. Some parts of the new district were not at present covered very densely with population, but the possibilities of extension in London, especially with an expanding system of locomotion, there was every assurance that that district, now sparsely peopled, would become very populous, and therefore very profitable to the company. He hoped this would prove profitable to the investors hereafter. They had also succeeded in excluding poachers from their district. Two attempts to invade their territory had been resisted. Not that they would have feared competition, but competition should be avoided in works of this kind, if it could be. It was thought by some that the meeting had been unduly postponed, but the board had little to report while the works were in progress, and there was little use in holding meetings until they had arrived at a definite stage in their work. He moved that the report be adopted.

Mr. Ernest Hill seconded the adoption of the report, and thought the directors had taken high fees (£1,409) for a company with a £100,000 capital, especially considering that the chance of getting dividends was somewhat remote.

Mr. Horace Boot, borough electrical engineer at Tunbridge Wells, proceeded to make a lengthy criticism of the report and the undertaking in general, but he said that his remarks were intended to improve, and if possible, to help the company in the future; and he asked them to accept them as such. He was not in any way anxious to "upset the show." He felt that they had a valuable area asset, and they ought to make the best of it, but if they were going to water it or play with it, no company under the sun could be anything less than a failure. Mr. Boot said he was more or less of an expert understanding the matters to which he referred. He asked, firstly, the number of free-wire consumers, as against the ordinary consumers; secondly, he found that the lamps applied and connected differed very considerably, and half the revenue that they might have earned was apparently lost, and he would like some explanation. Would the chairman kindly tell him the capacity of the proposed generating plant in kilowatts, as it was only stated as so many 8-C.P. lamps? He was anxious to get this statement for the purpose of verifying Messrs. Kincaid, Waller & Manville's report, where it was worked out at £97 10s. per kilowatt installed. He asked the price paid by the company for the temporary supply of current and the price paid to them by consumers. He would rather give no supply at all than a bad one. It would harm and ruin the company's interests for the next five years. It was generally known in the Blackheath district that they were obtaining a temporary supply from a company whose pressure every night gave consumers not more than red-hot hairpins. A circular ought to be sent to their consumers explaining the matter. As to the extension of area, he congratulated the board, and he also said that it was their duty to promote or supply light railways worked electrically. That part of a business was more profitable than the lighting branch, if prices were arranged correctly. As to the motors applied for (40 H.P.), he said that motors were by no means a blessing to a company, and the smaller the company the bigger the curse they were. They upset the pressure of supply, and necessitated running a very large engine during the day to keep the pressure steady, which meant a great waste of coal for perhaps only 40 H.P. That might right itself, but he did not look upon 40 H.P. as of any good whatever as a revenue-earning capacity. After referring to what he considered the high directors' fees, £288 per director, and suggesting that they each, for the present, take £50, he remarked that he believed that the resident engineer, who was responsible for doing the whole of their work, was receiving less salary than each of the directors. In regard to capital outlay, they, at Tunbridge Wells, had made more or less of a record, and their magnificent buildings, offices, engine room, boiler house, &c., cost something like £6,000, and up to date they had a revenue of £9,000 to £10,000. The Blackheath Company, so far, had spent £17,818 upon buildings, and he compared the two figures which made those of the company appear to him as very excessive. Were there any engineers' certificates still to be passed under that head? Why were alterations to the new offices necessary at the cost of £100? Directors' names ought to be submitted to the shareholders before there were elected. Could they not get some approximate date as to supply? He asked the directors in future reports to give more working details. He was particularly interested in those details, because it enabled him to put his finger upon the weak points, and he was anxious to see his shares at a high price, and he was anxious to eradicate the weak points.

Mr. Snape (a large original shareholder) said Mr. Boot was somewhat pessimistic—he would not say hypercritical—in his criticisms. He was the engineer at Tunbridge Wells, he believed, and it might be that "two of a trade did not agree." His objection to the report that instead of stating in kilowatts, the statement had been made in candle-power only, was hypercritical, because he could easily make a simple calculation. He did not know whether it would have been policy for the company to have refused to give temporary supply of light until the works were finished. They were not to blame if the light was a bad one. He would emphasise the necessity of considering the desirability of supplying, not merely the large consumers, but the multitude. Had the board considered the effect of third class passengers on railway revenues, and the working class on gas consumption. If not, they would be astounded by the results obtained by catering for the multitude. They were better than catering for the large consumer. Was there sufficient space in the buildings for enlargement of plant when the increased demand from the new areas came along? If the resident engineer was not being paid sufficiently well, pay him better. He must see that the work was going on as well as the consulting engineer had planned it. Would the chairman give an approximate date for supply, so that they might be able to tell when they are likely to be paying dividends? He considered that the hard work of the board was at the initial stage when the business and works were being established, and they were not justified in complaining at the amount charged for fees.

The Chairman said the board did not resent criticism, but, on the other hand, he thought that the points raised would be found to be not weak points at all, but really strong points in their favour. No doubt there was a disparity between the lamps connected and the lamps ordered, but there was no urgent need for connecting them until the mains were in a position to supply light, and Mr. Boot's own argument was their best justification that they should not put in lamps to houses, while they had an uncertain and inefficient supply. The present plant in kilowatts which they are now providing will represent about 750 KW., including spare. On the question of buildings, it was hardly fair to compare work of this kind, necessarily expensive, with the works adapted to a place like Tunbridge Wells, which would be to a large extent fixed and the requirements known. They had set up plant sufficient for present needs, and had also spent a considerable sum in providing larger premises than would otherwise be immediately required, and the chimney would serve a generating station of double the size. For the temporary supply they paid 4d. and received 6d. per unit. The board realised the importance of the income from a day-time power supply. After further remarks showing that the small consumer was being well catered for, he said he thought they might be able to commence supply within a month. The knowledge and work which had been brought to bear upon the business by the directors quite warranted the fees charged, but whether the fees were adequate or the reverse they were fixed by the articles.

The resolution was carried unanimously.

Messrs. Chalmers, Wade & Co. were elected auditors, and the usual vote of thanks closed the meeting.

Renewable Electric Lamp Company.

The statutory meeting of this company was held on 22nd ult. at the offices, 11, Charing Cross Road, W.C., Mr. Jacob Atherton, presiding. No notice of the meeting seems to have been given to ourselves or to other electrical journals, therefore we have to depend upon reports appearing in the financial papers for the following particulars of the proceedings:—

The Chairman described the nature of the operations that have taken place during the last four months. The directors took into serious consideration the question of the location of the works. Works for a business of this nature are indispensable. First of all, they must be able to produce a first-class article, as that article had to be dealt with so many times over; that is to say, a lamp made under the company's patents has to be renewed time after time, and from that point of view it is absolutely necessary to make a first-class article. The directors took considerable trouble in finding a suitable site, but at last found one at Brunswick Place, City Road, Shoreditch. They took the advice of an expert lamp maker, a man who had been connected with this business for the greater portion of his lifetime, and he confirmed the impression made on their minds that this was the most suitable place for the works, and expressed the opinion that they were capable of taking in machinery for the supply of about 10,000 lamps per day. They had taken the buildings on a very favourable lease, having 50 years to run, at a moderate rent, and had the option of buying the ground rent any time during the first seven years at a price of £4,000. The directors would have to decide later as to the expediency of buying it. They had appointed a first-class lamp maker to take charge of the works on moderate terms. They had appointed a general manager to look after the commercial side of the question, and he has gone so far as to lay out the works

for equipment with the most modern machinery for producing lamps, so that they were in every sense of the word, an up-to-date lamp manufacturing company. They had the benefit of the experience of their managing director, who has been connected with the electrical industry for a great many years, and, perhaps, with one of the most successful supplying stations in London. Their expert advised them that they would be in a position to turn out lamps in fairly large quantities within three months from the present time. In the meantime they had made an engagement with a friendly English lamp manufacturing company to supply 2,000 lamps per week, in order that they might furnish the various supply stations, companies, hotels, clubs, and very large consumers of lamps with small parcels, in order to give them some practical experience pending the time that the lamp works are fully equipped at Shoreditch. Important large contracts have been entered into with large public bodies in various parts of the country and in London. They had, in fact, more orders than they could execute at the present time, and many large buyers are waiting for the time when they could give deliveries. The chairman said: "It is now customary for supply companies to include our lamp in the price of their supply of current, and in the near future it is expected that our business will be done with these public companies, who are anxiously looking forward to an efficient lamp at a moderate price, and one that can be renewed over and over again. In other words, it is intended that this company shall do for electric consumers what the Welsbach mantle has done for gas consumers. I do not think I can say anything further." When our annual meeting takes place we shall be able to present a fair and satisfactory report.

Prospectus.

In our advertisement pages to-day will be found the prospectus of the Electrolytic Alkali Company, Limited ("Hargreaves-Bird" process.) An article regarding the process will be found in our issue for last week and also that for August 5th, 1898, and some further notes by Mr. Kershaw appear on another page this week. The list of subscriptions opens on Tuesday next, December 5th, and closes on Thursday, 7th. The capital is £300,000, divided into 200,000 7 per cent. cumulative preference £1 shares and 300,000 £1 ordinary shares. The present issue is for £300,000, of which £200,000 will be available for the purchase of land and erection of works and plant, and for working capital, &c.; 50,000 ordinary shares are reserved as part of the consideration to be paid to the parent company, and £100,000 preference and £150,000 ordinary are offered to the public. The prospectus gives copies of reports by chemical and patent experts and accountants. The parent company, who are the promoters, receive £100,000 in cash and shares for the United Kingdom patents, and for the land, &c., at Middlewich £15,000 in cash is payable. Applications may be obtained from the secretary (*pro tem.*) of the company, Mr. James Barron, Farnworth, Widnes, Lancs., and from the bankers, solicitors, and auditors.

Stock Exchange Notices.—The Stock Exchange Committee have (1) appointed special settling days as under:—Wednesday, December 6th—Metropolitan Electric Supply Company, Limited—125,000 3½ per cent. mortgage debenture stock. And (2) ordered the undermentioned securities to be quoted in the Official List:—County of London and Brush Provincial Electric Lighting Company, Limited—£200,000 4½ per cent. debenture stock in lieu of the provisional certificates now quoted; Metropolitan Electric Supply Company, Limited—£125,000 3½ per cent. mortgage debenture stock.

Electrical Undertakings, Limited.—Another meeting of this company was held on Tuesday at Winchester House, E.C., and our representative was again refused admission, as the proceedings were stated to be private.

Meeting.—A meeting of the Cape Electric Tramways Company was held yesterday afternoon. A report will appear next week.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending November 25th, 1899, were £159 19s. 7d.; November 25th, 1898, £139 14s. 7d.; aggregate for half-year to date, £19,575 17s. 0d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending November 24th, 1899, were £2,650 5s. 9d.; corresponding period, 1898, £2,454 17s. 6d.; increase, £195 8s. 3d.

The City and South London Railway Company.—The receipts for the week ending November 26th, 1899, were £1,035; November 27th, 1898, £1,114; decrease £79. Total receipts for half-year, 1899, £21,488; total receipts corresponding period, 1898, £21,518; decrease, £30. Miles open, 3½.

The Dover Corporation Tramways.—The receipts for the week ending November 25th, 1899, were £158 4s. 0d.; November 26th, 1898, £133 14s. 1d.; increase, £24 9s. 11d. Total receipts to date, 1899, £9,308 3s. 11d.; corresponding period, 1898, £7,786 7s. 10d.; increase, £1,521 16s. 1d. Miles of track open, 1899, 3; 1898, 2. Car miles run, 1899, 4,791; 1898, 4,371. Number of cars, 1899, 11; 1898, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, November 24th, 1899, were as follows:—D. U. T. Co., horse cars, £169 19s. 2d.; ditto, electric cars, £2,726 14s. 8d.; D. S. D. Co., electric cars, £674 9s. 2d.; total, £3,571 3s. 0d.; corresponding week last year—D. U. T. Co., horse cars, £2,042 5s. 11d.; ditto, electric cars, £422 1s. 10d.; D. S. D. Co., electric cars, £572 2s. 2d.; total, £3,036 9s. 11d.; increase, £534 13s. 1d. Aggregate to date, £89,241 13s. 10d.; aggregate to date last year, £85,249 1s. 8d.; increase to date, £3,992 12s. 2d. Worked:—The mileage open is 39 miles electrically, 5 miles by horses, as against 16 miles electrically, and 26 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending November 26th, 1899, were £575; November 30th, 1898, £209; Increase, £366. Number of cars, 1899, 28; 1898, 10. Total receipts to date, from April 1st, 1899, £20,620; 1898, from June 20th, 1898, £5,881. Miles of track open, 12; 1898, 3½.

The Liverpool Overhead Railway Company.—The receipts for the week ending November 26th, 1899, amounted to £1,477; corresponding week last year, £1,317; increase, £160 Total receipts for half-year ending November 26th, 1899, £35,738; corresponding period last year, £34,355; increase, £1,383.

The South Staffordshire Tramways Company.—The receipts for week ending November 24th, 1899, were £529 5s. 7d.; November 25th, 1898, £559 13s. 1d.; aggregate receipts for 47 weeks £31,279 2s. 4d.; 1898, £29,739 2s. 1d.

STOCKS AND SHARES.

Wednesday Evening.

The Stock Exchange has been in one of its pessimistic moods for the past week, and prices in every department have suffered more or less. The principal cause of the trouble has been, and still is, the stringency existing in the money market. As we have remarked in an earlier issue, investors will not buy securities which only return them 4 per cent. or thereabouts, at a time when money can be lent upon excellent security to the Stock Exchange at 6 or even 7 per cent. This week has seen a slight decline in prices of the Electrical Supply section; Westminsters and St. James's are the principal losers, but Metropolitans have also weakened. The late action of the company at Willesden is the subject of a good deal of market comment, but the irritation is not likely to impress itself on anybody's mind. The old shares and the new are now the same price, and both can be bought at about 15. Charing Cross new are 10 middle.

Some attention is being directed to the marvellous progress which Germany is making with regard to electrical work, and suggestions are in the air as to the advisability of one of the principal British Companies opening a branch in the Fatherland, but no step has yet been made in this direction.

The telegraph market is quiet. Easterns are scarcely moving, nor did the price change at the announcement of the company's having successfully completed and opened a section of its third cable to South Africa on Monday last. Communication with the Cape and Natal has again been delayed owing to the now familiar "breakdown on the line," and the two incidents neutralised each other so far as the Stock Exchange is concerned. Anglo-American varieties present very little alteration, but Submarine Cables Trust stock is down 2 per cent. This, of course, is due to the new issue which is to be made, particulars of which we gave a week ago. Brazilian Submarines are considered a good investment in the market. The price is now 15½, at which a purchaser gets 4 per cent. and a trifle more, upon his money, assuming that the usual 7 per cent. dividend is maintained. We must say, however, that the outlook for Brazil herself during the next few years is not particularly encouraging, and the prosperity of the Brazilian Submarine is naturally largely dependent upon the state of affairs in "the land where the nuts come from."

Prices of electrical railway stocks are in no way affected by the columns of Parliamentary Bills relating to this branch of traction which are to be presented next session. Among the notices are several applications for an extension of time for building, as in the case of the Brompton and Piccadilly, the Charing Cross and Euston, and the Baker Street and Waterloo lines. This will no doubt occasion some little disappointment to those financially interested in the various schemes, but that an extension would be inevitable has been patent now for some considerable time. There are several ambitious projects for electric railways in different parts of the kingdom, and it seems probable that the idea will be hugely developed in the new century. One of the lines talked about is that which, it is said, Mr. Carnegie and a syndicate are going to build from Croydon to Brighton. These are, of course, early days to express any kind of opinion as to the likelihood of such a line being successful, but the idea is not a new one, by any means. London and Brighton stock has been weak upon fears that the contemplated electric railway will be a severe competitor, but such anticipations are more premature than intelligent.

British Electric Traction do not move, but the market is not a very good one. The old Preference have shed another ¼ for the reasons connected with the new issue to which we referred last week.

Henley's have recovered their former position in the Official List, both Ordinary and Preference reappearing. The former are 13½, while the Preference hover around about 5½.

National Telephone issues are harder, and already dividend forecasts are being whispered. The ordinary shares are ½ better, and the Third Preference have also been bought. Business in them, however, is very quiet.

From New York comes intelligence of a gigantic Trust that has been formed of the United States electrical fanmakers. The new combine, it is said, will start with a share capital of five millions sterling. We should have thought that after her recent experiences in this direction, America would have eschewed "Trusts" for some considerable time.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Nov. 22nd.	Closing Quotation, Nov. 29th.	Business done during week ended Nov. 29th, 1899. Highest.	Lowest.
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red	100	...	...	...	85 — 90	85 — 90	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	66 — 69	66 — 69	...	...
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	117 —118	117 —118	117⅞	116⅞
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	17⅜— 18⅛	17⅛— 18	18⅛	17⅝
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15½— 15¾	15 — 15⅛	15⅛	15⅜
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	198 —202	198 —202	...	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	103 —105	103 —105	104½	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½%	1 %	⅛— ¼	⅛— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20 xd	19 — 20	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	103 —107%	103 —107%	...	...
60,710£	Direct United States Cable	20	3 %	3½%	3½%	12 — 12½	11⅝— 12⅛	12	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	101 —104	101 —104	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	7 %	158 —163	156 —161	162	158
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	99 —102	99 —102	100½	99½
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	...	... ...	... ...	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	117 —122	117 —122	...	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	15½— 16	15½— 16	16	15 13/16
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	118 —123	118 —123	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
800,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	101 —104	101 —104	...	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—3,000	25	4 %	...	...	101—104% xd	101 —104%	101	...
180,237	Globe Telegraph and Trust	10	4½%	4½%	5½%	11½— 11⅝	11½— 11⅝	11½	11½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15½— 16	15½— 16	15 13/16	15 13/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	31 — 33	31 — 33	...	...
89,500	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	48 — 52	48½	48
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	106 —109	106 —109	...	...
71,000	Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000	1	...	...	...	⅛— ¼	⅛— ¼	...	...
84,000	Do. do. 5% Pref., Nos. 1 to 84,000	1	...	...	...	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	5½%	6 %	6 %	5 — 5¼	5 — 5¼	5 7/16	5⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5½	5¼— 5½	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 —102	100 —102	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	¾— 1	¾— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	...	103 —106	103 —106	...	...
11,889	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
8,281	Submarine Cables Trust	Cert.	...	...	...	130 —135	128 —133	130	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733£	Do. do. 5 % Debs.	Stock	...	...	...	105 —108	105 —108	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	%	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	102 —105	102 —105	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red.	Stock	...	...	...	104 —107	104 —107	...	...
68,321	West India and Panama Telegraph	10	1 %	⅛%	...	1 — 1½	1 — 1½	1⅛	1
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10½— 10⅝	10 — 10⅛	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9 — 10	8 — 9	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	106 —109	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	...	4 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	...	9 — 10	9 — 10	...	...
30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10 — 11	10 — 11	10⅜	10⅜
20,000	Do. do. do. do. Nos. 30,001—50,000	5	...	...	...	...	9½— 10⅛	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
34,000	*Chelsea Electricity Supply, Ord.,	5	5 %	6 %	6 %	8 — 9	8 — 9	8¼	8⅛
100,000	Do. do. do. % Deb. Stock Red.	Stock	4½%	4½%	...	111 —113	111 —113	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000	10	7 %	10 %	6 %	11½— 12½	11½— 12	12¼	11⅝
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	13 — 14	13 — 14	13⅜	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	126½	126
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	nil	10½— 11½	10½— 11½	11	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	13 — 14	13 — 14	13½	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	111 —114	111 — 114	112⅝	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	...	5 %	7 %	5 — 5½	5 — 5½	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	3 — 3½	2⅞— 3⅛	3 1/16	3 1/16
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6 — 6½	6 — 6½	6⅜	6 5/16
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	104 —106	104 —106	105½	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	15 — 16	14½— 15½	15⅝	15
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	14½— 15½	14½— 15½	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	117 —119	117 —119	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	15½— 16½	15½— 16½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	16 — 17	15½— 16½	16½	16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
65,000	South London Electricity Supply, Ord., £4 paid	5	...	...	...	3½— 3⅝	3½— 3⅝	3 3/16	3½
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	9 %	12 %	12 %	14½—15½	14 — 15	14½	14

* Subject to Founder's Shares. ‡ Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Nov. 22nd.	Closing Quotation Nov. 29th.	Business done during week ended Nov. 29th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	2¾— 3½	2¾— 3½	3	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	16½— 17	16½— 17	17	...
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	13½— 13⅝	13 — 13½	13⅝	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	...	11½— 12½	11½— 12½	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6½— 6⅝	6½— 6⅝	...	...
90,000	Brush Elecl. Engng., Ord., 1 to 90,000	3	nil	3 %	5 %	1⅞— 2⅛	1⅞— 2⅛	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	4 %	6 %	6 %	2¼— 2½	2¼— 2½	2 5/16	...
125,000‖	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —115	110 —115	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½%	15 %	13 — 14	13 — 14	...	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	...	5½— 6	5 1/16	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	113 —116	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10⅜	10¼— 10⅜	10⅜	10⅜
178,308	Do. do. do. £8 paid	10	...	...	...	...	...	...	...
61,088	Do. do. Pref. half-shares	5	...	...	...	4¾— 5¼	4¾— 5¼	5	...
71,447	Do. do. Def. do.	5	...	...	...	5¼— 5⅝	5¼— 5⅝	5 7/16	5 5/16
630,000‖	City and South London Railway	Stock	1 9/16 %	1⅞%	2⅛%	63 — 66	63 — 66	64	63
37,000	Do. do. Ord. shares, Nos. 22,501 to 60,000	4½	...	...	...	...	3½— 4½	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4½	3½— 4	...	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	6 %	2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	6 %	3½— 4½	3½— 4½	4⅛	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	95 — 97	95 — 97	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2 — 2½	2 — 2½	2 3/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	2⅝— 3½	3	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	104 —107	104 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ½	¼ — ½	...	...
9,600‖	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	11 — 13	11 — 13	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	10 %	12 %	14 %	...	13 — 14	...	...
6,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	7 %	...	5½— 5⅝	5⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	111 —114	111 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	3½%	3½%	9 — 9¼	8¾— 9	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13¼— 13¾	13¼— 13¾	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	103 —106	103 —106	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¼— 9¾	9 — 10	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000‖	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	101 —104	101 —104	...	...

† Quotations on Liverpool Stock Exchange.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½% Debentures of £100, 105—108.
National Electric Free Wiring, 10s. paid, 5s.—7s.
Oldham, Ashton, and Hyde Electric, Ord., 19—19½.
Do. do. Pref., 10⅞—10⅞.
Smithfield Market Electric, 1—3.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7¼—7⅜. Debentures, 104—107. Dividend, 1898, on Ordinary Shares 10%.
Kidderminster and District Electric, Pref., 6—6½ xd.
*T. Parker, £10 (fully paid), 18¾.

Bank rate of discount 5 per cent. (October 5th, 1899).

MARKET QUOTATIONS, Wednesday, November 29th.

CHEMICALS, &c.		This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	40/-	40/-	..
a Ammonia, Muriate (crystal) ..	per ton	£29	£29	..
a " "	per ton	£27	£27	..
a Bleaching powder	per ton	£6 10	£6 1	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£16 10	£16 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25 10	£25 10	..
a Lead, Nitrate	per ton	£35	£25	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8¼d.	8¼d.	..
a " Caustic (75/80 %) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£7 10	£7 10	..
Crystals	per ton	£3	£3	..
a " Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b " Sheet, in ton lots..	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£90 to £160	£90 to £160	..
c Brass (rolled metal 2' to 12') basis	per lb.	8¼d.	8¼d.	..
c " Tube (brazed)	per lb.	10d.	10d.	..
c " Wire, basis	per lb.	8¼d.	8¼d.	..

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
f Ebonite Rod	per lb.	3/-	3/-	..
f " Sheet	per lb.	5/-	5/-	..
g Copper Bars	per ton	£85	£85	..
g " Wire (basis price) ..	per lb.	10½d.	10½d.	..
g " Sheet	per ton	£85	£85	..
g " Rod	per ton	£85	£85	..
m German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	7/-	7/-	..
h India-rubber, Para fine ..	per lb.	4/6½ to 4/7½	4/5 to 4/7	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants)	per ton	(69/1½	69/10d.	8½d. dec.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	50/- to 55/-	50/- to 55/-	..
i " Wire galvanised No. 8 ..	per ton	£14 5	£14 5	..
g Lead, English Ingot	per ton	£17 12 6	£17 12 6	..
g " " Sheet	per ton	£18 16	£18 16	..
m Manganin Wire No. 28.. ..	per lb.	8/-	8/-	..
g Mercury	per bottle	£9 10	£9 10	..
d Mica (in original cases), small	per lb.	2d. to 8d.	2d. to 8d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large	per lb.	3/6 to 7/6	3/6 to 7/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet	per lb.	From 1/2½	From 1/2½	..
o Platinum	per oz.	£3 11	£3 11	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	p. ton	From £15	to £40	..
i Steel, Magnet, in bars		£59	£58	..
g Tin, block	per ton	1 19 1)	£133 10	£3 dec.
g " foil	per lb.	1/6	1/6	..
n " wire Nos. 1 to 16	per lb.	1/11	1/11	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles	per lb	7¾d.	7¾d.	..
j " Best Flax, 6 lea. ..	per lb.	5d.	5d.	..
j " Hemp, 8 ply 10 lbs. ..	per lb.	8¾d.	8¾d.	..
j " " Russian, 10 lbs.	per lb	4¾d.	4¾d.	..
j " Jute, 180 lbs. rove ..	per ton	£14	£14	..
k Zinc, Sheet (Vielle Montagne bnd.)	p.t	£26	£26	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakespeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

PRESIDENTIAL ADDRESS

By Prof. Silvanus P. Thompson, D.Sc., F.R.S., President.

(*Delivered Thursday, November 16th.*)

(*Concluded from page* 833.)

Passing from the generation of current to its utilisation for electric traction, the most notable evolution now in progress is that of the application of electric power to heavy railways. The application to street railroads—in other words to mere tramways—has been an accomplished fact for ten years on the other side of the Atlantic, where there are now thousands of miles of electric tramways, mostly operated from overhead lines from which the current is taken by a contact trolley wheel. If in this country the development of electric tramways has been slower, we have at least the advantage that our cities are not disfigured by networks of overhead trolley lines. No such objections hold good for rural districts, and slowly but surely both the industrial and agricultural districts of England are being furnished with electric intercommunication with its many attendant advantages. It may come as a surprise to many who think England behindhand in this respect, when they learn that while the total subscribed capital invested in this country in 1899 for public electric supply is about £17,800,000, no less than £20,800,000 is already invested in electric traction. Of the effect of the introduction of electric traction as a social and economic factor I have spoken elsewhere. There can be no question of the immense social benefit, particularly to the artisan population, afforded by this means. But the electrical engineer is now engaged on the still greater problem of operating heavy railways, and the development in this branch is being watched with keen interest. The two deep level railways in London, the City and South London Railway and the Waterloo and City Railway, both of which have amply justified their promoters, are shortly to be supplemented by the Central London Electric Railway, an undertaking of much greater magnitude, while several other similar schemes are either under construction or authorised. In the City and South London Railway the rolling stock is designed for separate electric locomotives, each drawing three passenger cars. The gauge is 4 feet 8½ inches. On the Waterloo and City line the trains consist each of four cars, of which the two end ones are fitted with motors, four motors on each terminal car, so that the train can be driven by either set of four motors. Each train can carry 204 passengers. The gauge is 4 feet 8½ inches, but owing to the size of the tunnel, ordinary railway rolling stock could not be used. In the Central London line the gauge is also 4 feet 8½ inches. The locomotives, each with four gearless motors, weigh 35 tons each. Each will draw a train of seven cars, with a seating capacity of 336 persons per train. The total length, including sidings and cross-over lines, exceeds 8 miles of double track.

In all three of these railways the current is taken from a third rail on the surface, and the return circuit is through the ordinary rails, which, for this purpose, are bonded with copper bonds. All these lines are operated by continuous currents at 400 to 500 volts. In the case of the Central London line, part of the feeding is effected through rotatory converters which receive three-phase currents from step-down transformers.

In sharp contrast to these three London undertakings is the Burgdorf-Thun railway in Switzerland, which was opened in July last. It is in every sense of the word a full-gauge railway. Not only is its rolling stock full gauge (the full gauge of Switzerland is 4 feet 8½ inches), but the railway admits of use by ordinary steam locomotives, drawing ordinary trains. The electric rolling stock is of two kinds—automobile cars carrying 66 passengers each, for use singly or in pairs, and locomotives of 300 H.P. each, for drawing trains of ordinary carriages or goods wagons. This railway is worked by alternating currents supplied in three phases, at 750 volts, the feeding being effected through stationary transformers at 16,000 volts. The currents are taken from two overhead conducting wires, the rails serving as the third conductor. The length of line thus electrically equipped is 40 kilometres, or 26 miles. The arrangements were designed, and the electrical equipment constructed, by Messrs. Brown, Boveri & Co., of Baden, who were the first to apply three-phase currents to traction. In the Lugano tramways as a commencement, then in the steep mountain light railways of Engelberg, of the Gornergrat, and lastly of the Jungfrau, they gained experience in this method, which now stands triumphantly demonstrated in its adaptability to the service of heavy lines. In the United States heavy railways have been, to a very limited extent, operated by electric locomotives. Some built for the Baltimore and Ohio Railroad, weighing about 90 tons, are employed to draw ordinary trains over a short line around part of the city of Baltimore. They work with continuous currents from overhead trolley lines.

There can be little doubt, however, that to Switzerland rather than to America we must look when desiring guidance as to the future development of this problem. All necessary data now exist for the exact working out of the necessary equipment of any given line, actual or projected. No experiments are needed to enable the constructor to proceed, so soon as it shall have been determined which kind of current is to be used. Already it has been found in the designing of the Central London line that continuous current methods, however suitable for light and short railways, and for tramways where frequent stoppages occur, fail when the current has to be supplied from a distance of several miles, alternating currents being brought in because of their greater economy in transmission. The extraordinary thing is, that this having been so far grasped, the whole of the rest of the equipment was not designed to match with three-phase motors, instead of introducing the complication of rotatory converters to work continuous current motors. Time alone can show how the mixed system adopted will work in practice. To me the choice of the mixed system appears of doubtful wisdom. Perhaps the distinguished engineers who are understood to be spending £30,000 on experiments for the Metropolitan Railway to enable them to recommend the best system for our inner circle underground line will shortly be able to report whether a simple three-phase system throughout is, or is not, more economical than either a continuous current system throughout or than a mixed system with converters. If they do not settle this question, which is to-day the one important question in electric railway work not yet settled, we must regard the expenditure as pure waste.

Returning to the question of electric tramways, the problem of the hour is the equipment of busy city thoroughfares, where, for obvious reasons, overhead wires are inadmissible. To all the three possible methods that dispense with overhead construction, viz., by accumulators carried on the car, by use of slot conduits in the road, and by use of surface contacts, objections are not wanting. Accumulators are found too heavy and too short-lived to be satisfactory. Conduit constructions are objected to as too costly, and as interfering too much with the roadway, while to surface contacts there is brought the terrible indictment—worse than any against the conduit—that nobody has had experience of them. You are aware that in this question of surface contact systems of tramways I am an interested party, and cannot be expected, even in a presidential address, to speak dispassionately. Yet you have never expected your president to banish from his inaugural address the topics to which he has devoted his thoughts, his energies, his time, or his resources. And with the examples before me of other presidents who have spoken of their own work, I take the liberty of speaking of mine. A paper dealing with some aspects of surface contact working was read by me at the Bristol meeting of the British Association, and in January last you listened here to a paper on some other points by Mr. Miles Walker, my former assistant, and partner in this matter. We have, indeed, worked out several different systems, of which the earlier only have yet been publicly described. We are at work on modified plans, the result of our experience gained on our short experimental line at Willesden; and before long we expect to demonstrate the advances we have in hand. Meantime we are not alone in the field. Since the time when the late Dr. Hopkinson proposed his original plan, many others, including Mr. Wynne, Mr. Holroyd Smith, Mr. Esmond, and Messrs. Johnson and Lundell, have suggested various new methods. Three years ago Dr. Hopkinson wrote of one of these methods that he "would not hesitate to approve its adoption in any town in which overhead conductors were inadmissible"; adding that he had "not the least doubt that it would work thoroughly, effectively, and safely." A good deal has happened since then, and much experience has been gained. But there remains not only in London, but in many provincial cities, crowded thoroughfares where overhead construction is absolutely out of the question, and where a slot-conduit would be almost equally objectionable. It is some years since Mr. J. Love equipped slot-conduit lines in Washington and Chicago. It is now most significant that in three great capitals—New York, Berlin, and Paris—the electric tramways are being largely extended without overhead wires. New York and Berlin are putting down slot-conduits; New York, most expensively, as if the object were to put as much cast-iron as possible into the roads; and the conduit at every 15 feet is furnished with pairs of hand-holes, the covers of which interfere with the surface quite as much as any surface-contact system, to say nothing of the interference of the central slot or of trouble about drainage. In Paris, on the other hand, where a tentative surface-contact system has for about a couple of years been tried with moderate success, no fewer than 63 kilometres—about 48 miles—are now being equipped by Mr. Diatto on his surface-contact plan which has been in successful operation on a small scale at Tours. Surely, then, if a method of surface contact can be shown which is at once simple, safe, and not too expensive, there is every reason to urge its adoption on engineers and municipal authorities. Thanks to the criticisms — some of them passed in this place—with respect to possible difficulties likely to arise from the use of underground coils, from mercury switches, and from surface leakage around the contact studs, improvements have been worked out which largely, if not wholly, remove the fears that have been expressed on these grounds. As contrasted with the conduit, a surface-contact system has the advantages of much lower prime cost, of less interference with the roadway, and of not requiring any drainage arrangements. On long lines that run out into the country it can be operated with the same cars that carry trolley poles for use in the suburban part of the track. Those cities and towns which, like London, Birmingham, and Cambridge, have waited before erecting overhead lines, will have justified their waiting attitude when they can point to examples of the successful surface-contact roads at Monaco, at Tours, and, lastly, at Paris.

Time forbids me to dwell further upon this topic; it precludes me likewise from entering upon a number of other topics of great interest, such as the development of the single-phase motor; the establishment of electric time services by synchronised dials throughout buildings, blocks of offices, or whole municipalities; the use of prepayment meters; the recent developments of electro-metallurgy; the revolution in chemical manufactures by the use of electric methods; the use of aluminium wires in place of copper wires as conductors; and last, but not least, seeing that Atlantic liners can now signal their presence when 50 miles from port, the progress of telegraphy without communicating wires. In all these many directions there may be noted pronounced tendencies toward development along distinct lines of progress, and some of these topics will doubtless form the subjects of discussion at our meetings during the session now beginning. I venture also to express the hope that the question of

the distribution of electric energy on the large scale may be brought before our members for discussion. Nothing can be more helpful to the industry generally, just at present, than the free discussion of a topic which is likely again to engage the attention of Parliament, and which ought to be discussed from the standpoint, not of restricted parochial or municipal interests, but of its bearing on the wider interests of national and public economics, and of the industry at large.

In commemoration of the centenary of the discovery of the pile, by Alessandro Volta in 1799, the city of Como, his birthplace, has this year held high festival. Beyond contest this discovery of a means of generating chemically a steady electric current constitutes the starting point of the entire modern development of the science of electricity. Though that modern development turns upon the subsequent discoveries and inventions of others—the discovery of the magnetic properties of the current by Oersted, the invention of the soft iron electro-magnet by Sturgeon, the discovery by Faraday of the fundamental principles underlying the dynamo and the transformer, together with many others of lesser moment—it still remains true that to the genius of Volta we owe the initial impulse. His memorable letter of June, 1800, to Sir Joseph Banks, first describing the pile, marks the opening of a new epoch in the history of civilisation. Without that discovery we now possess, neither telegraph nor telephone, neither electric light nor electric power, electrotyping and electroplating, would not exist. Commerce, diplomacy, warfare, and journalism would have remained in a totally different stage of development from that in which they are to-day. In brief, we should—with the modifying circumstances of the steam engine existing for power, and the gas jet for light—be still living in the stage of civilisation of the 18th century.

The Volta centenary was commemorated at Como by the erection of an exhibition and the holding of a series of celebrations. Unfortunately the exhibition was destroyed on July 9th by a calamitous fire, in which not only a fine collection of modern electrical machinery was destroyed, but a number of Volta's original manuscripts, and a considerable part of his historical apparatus perished. Happily the original pile and numerous other relics were saved, and are now enshrined in the Civic Museum of Como. Nothing daunted, the citizens of Como reconstructed their exhibition, which was re-opened in 42 days. Amongst the Como celebrations were held two congresses; one a congress of telegraphists, in June; the other a congress of electricians, in September. No invitation to send delegates to the former was received by this Institution, and neither it nor the British Post Office was officially represented. Four English telegraphists, none of them members of this Institution, were reported as having been present. This congress, having been convened by the Italian Minister of Posts and Telegraphs, and being attended by official delegates of various European Administrations, many of them telegraph engineers of the highest distinction in their various countries, it is extraordinary, to say the least, that the English Postmaster-General was not represented on the occasion. The congress of electricians was organised by the co-operation of the Physical Society of Italy, of which Prof. Róiti, of Florence, is president, and of the Italian Association of Electrical Engineers, which has branches in Milan, Turin, Genoa, Rome, Naples, and Palermo, and of which Prof. the Hon. Giuseppe Colombo is president.

At this congress, at which distinguished electricians from France, Germany, Holland, Switzerland, and Finland were present, this Institution was represented by Prof. Ayrton, Past President, and by myself. The Italian physicists and electrical engineers attended in great force. The proceedings of the congress were carried on with great vivacity; and many matters of the highest scientific and technical importance were discussed in its various sessions. After the sittings were concluded, two days were devoted to visits to the large generating stations at Paderno and at Vizzola; the former taking power from the river Adda (which flows out of the Lago di Como), and supplying electric current for transmission at high voltage to the city of Milan; the latter, not yet quite completed, taking water from the river Ticino, which drains the Lago Maggiore, and distributing its currents to the industrial towns of Gallarate, Legnano, and Somma Lombardo, within a radius of some 25 miles. Alike from the point of view of electrical and hydraulic engineers these stations are of the highest interest, presenting as they do special features different from those of almost all other kindred enterprises. Our Italian brethren may well be proud of the engineers who have found the solutions for these special problems of construction, and carried those solutions to practical success.

This year is also marked by the establishment, with a Government grant, of the National Physical Laboratory for the standardising and certification of scientific instruments, and for physical research on well-defined lines. Though thus commenced on a modest scale, the circumstance marks an event of national importance.

I cannot forbear to direct your attention to another matter of public interest, and one which exercises an influence on all attempts at developing new enterprises. It is only too notorious that the whole question of financial development of new inventions is in this country in a most unsatisfactory state. The promotion of joint-stock companies under the Limited Liability Acts has become a public scandal. In the eighties a heavy blow was given to the real progress of electric lighting by the reckless promotion of bubble companies with inflated capital, causing the loss of millions of money upon foolish and worthless schemes. In the year 1882 no less a total than £23,000,000 of nominal capital was registered in electrical company schemes alone. In the nineties a similar reckless speculation has been witnessed over bicycles and automobiles. Happily electric traction has largely escaped this curse; and it will be an evil day for any of the newer developments of electrical engineering if a like craze should overtake them. There is something amiss in our economic machinery when such scandals can recur. Nothing is more familiar to those who have to deal with new inventions, or to those who, as consulting engineers, have to advise and report upon them than the ever-recurring difficulty of getting them financed on a sound basis. Suppose that there is an invention of a thoroughly sound character, properly protected by patents, but requiring time and money to establish itself commercially. Suppose that there is required a capital of from £10,000 to £25,000 to put it upon a commercial basis. In the present state of public finance in this country the inventor finds himself in this difficulty—he must either raise the necessary capital privately by personal effort amongst his own friends, or he must put it into the hands of a promoter, who will want to bring it out with a capital of at least £100,000. In other words, it is almost impossible to find a middle course between a purely private affair and an over-capitalised swindle. We have, unfortunately, in this country no organisation corresponding to the Industrial Banks of Germany, to the enlightened management of which the financing of sound schemes on a moderate scale can be entrusted. Much more might be said on this topic. It is one which affects not our industry alone, but it affects ours perhaps more than any other industry, because the glamour which is attached in the public mind to everything and anything electrical is made use of by the unscrupulous financier to the detriment of honest promotion.

I have already alluded to the sums of money which have been invested in this country in the supply of electricity for lighting and power, and in electric traction. According to Mr. Garcke's invaluable "Manual of Electrical Undertakings," from which I derive my figures, the aggregate subscribed capital in shares and debentures at the present date stands as follows:—

Telegraphs	£34,284,957
Telephones	7,729,626
Electric supply (companies)	9,265,793
" " (municipalities)	8,531,167
Electric traction	20,808,959
Electric manufacturing	16,799,152
Electro-chemical and miscellaneous concerns ...	8,558,065
Total	£105,997,716

This hundred millions of subscribed capital is much less, it is true, than that represented by the total capital invested in railways or in many other domains of British industry. But it is this electrical industry and the scientific and professional elements associated with it which our Institution represents to-day. Competing as we have to do not only in foreign and colonial markets, but even in our own home markets, with the manufacturers and engineers of other countries, it behoves us to do all we can to make our Institution of use to our members of all grades, and particularly to our younger members. One great duty which we owe to them is to furnish them with the latest information as to the progress of electrical development, the development not only of industrial undertakings, of new machinery, of new materials, and of new inventions, but also of pure science, upon which all technical developments are in truth based. From the very first year of our existence—1872—we have always issued, in our *Journal of Proceedings*, abstracts and extracts of scientific and technical papers published at home or abroad. Two years ago we joined with our colleagues of the Physical Society in bringing out in the monthly numbers of *Science Abstracts* a far more complete digest of electrical progress than we were previously in a position to produce. To carry on this publication both we and the Physical Society have had to devote considerable sums, and, indeed, one of the reasons why we had a year ago to raise the fees paid by our students was avowedly to meet the financial burden which we had thus assumed for the purpose of disseminating knowledge. I venture to think that every penny thus spent has been a most wise outlay, and one of which we are already beginning to reap the fruits. Our members all over the country and in distant lands are thus kept informed month by month of the progress of the science, and they increasingly appreciate their connection with the Institution. I know of no means better calculated to keep our younger men abreast of the times than by putting into the hands of everyone of them this admirable compilation.

But the needs of our Institution do not end with the effort to keep our members informed of the progress of science. We have other demands upon our funds of a very pressing character. The Benevolent Fund, established a few years ago upon an independent basis, has, though small, been available for helping necessitous members. In this connection every member of the Institution will rejoice to learn of a great and generous offer which has just been made to us. One of our honorary members, Mr. Henry Wilde—a name memorable as that of the pioneer in the sixties of the early forms of dynamo machine, both continuous and alternating, and of their application to lighting, to deposition of copper, and to the transmission of power—has offered to the Institution, and the Council has accepted, a sum of £1,500 for the purpose of constituting a Benevolent Fund. I need only mention this to secure your cordial acknowledgment of the great generosity of Mr. Wilde, whom two years ago we elected an honorary member in recognition of his claims on the electrical community.

From the very beginning we have been accorded by our generous hosts, the Institution of Civil Engineers, the privilege and advantage of holding our meetings in this hall. If some of us feel that with the rapid growth of our own body the time is coming when we ought to be taking active steps toward providing ourselves with a home of our own, it is not because we are not deeply grateful for that privilege. Nay, rather the circumstance that our growth compels us to contemplate this step is a perpetual reminder of the courteous generosity which has itself been no small factor in promoting our welfare and our increase. The founding of our Building Fund six years ago was due largely to the foresight and fostering care of our then treasurer and vice-president, Sir David Salomons. At his instigation we have

annually set aside such sums as we could spare from our surplus income, and our nucleus of a Building Fund stands this autumn at £5,000 so accumulated. The Council has for some months been quietly prosecuting inquiries for a suitable site; and it has recently decided to issue a circular drawing attention to the building fund, and suggesting to members of all grades the expediency of subscribing for the next few years an annual contribution thereto. If by this means we can treble or quadruple our present fund, we shall be ready at least to begin to build when a suitable site shall have been found. And it is most earnestly to be hoped that the generous example of Mr. Wilde will stimulate others of our wealthy members to rival his gift by valuable donations to the building fund.

Finally, I would speak of the growth of the Institution itself. From a total membership of 110 in 1872, we have increased to a total of 3,254 at midsummer, 1899, and statistics show clearly that the rate of increase is itself increasing. In the establishment of the new class of associate member we think we have secured a new element of strength. With the growth of total membership has come a new movement for the grouping of our provincial members in local branches. The Council has appointed a committee to organise these; and already preparations are on foot for constituting two local centres in the North, and another in Ireland; while our South African members have already constituted themselves informally into a local branch, holding meetings in Cape Town, which will shortly be officially recognised under our new articles of association. All these are signs of active progress. The novel departure made last summer, when the council sanctioned the suggestion of an official visit to Switzerland, has already borne fruit in many ways. The Swiss tour brought together many of those who, though active members of the profession, cannot often attend the ordinary meetings in London. It not only enabled us to see what Swiss engineers are doing; it brought us into the most pleasant personal touch with our able and courteous Swiss *confrères*, and it procured for us an invitation to pay a similar visit to Germany at a date in the near future. But, best of all, it has, I think, enabled some of us to realise more fully than we did before the value of our connection with our own Institution of Electrical Engineers; it has taught us what the power and usefulness of our Institution may be; and it has knit us together and inspired us to do what we can to promote its prosperity and the prosperity of the great industry which it represents. In this spirit, and with the note of progress sounding in our ears, let us carry on the work of the session now opened.

THE COST OF STEAM RAISING.

By John Holliday, A.M.I.C.E.

(*Paper read November 23rd, 1899.*)

(*Concluded from page 835.*)

For the other six boilers various fuels have been used at different times at prices varying with the state of the fuel market; in 1895, however, most of the work was done with a South Wales coal, consisting of about 30 per cent. large, the rest fine, which was delivered at the boiler at the price of 14s. 6d. per ton; this fuel contained about 10 per cent. of incombustible, and under the existing conditions evaporated about 9·5 lbs. of water per pound of fuel. Taking the cost of evaporating 1,000 gallons of water with this fuel, as was done above for the breeze, we have

$$C = \frac{P}{W} \times 4{\cdot}464$$

$$= \frac{14{\cdot}5}{9{\cdot}5} \times 4{\cdot}464$$

$$= 6{\cdot}81 = 6\text{s. } 9\tfrac{3}{4}\text{d.}$$

which is in remarkable contrast to the 2s. 8½d. found to be the cost of the breeze to do the same work. In these boilers evaporation is at the rate of about 3,800 lbs. of water per hour per boiler, equivalent to 190 H.P. at 20 lbs. of steam per horse-power per hour, or 11·7 per cent. more power per boiler than in the case of the boilers fired with breeze.

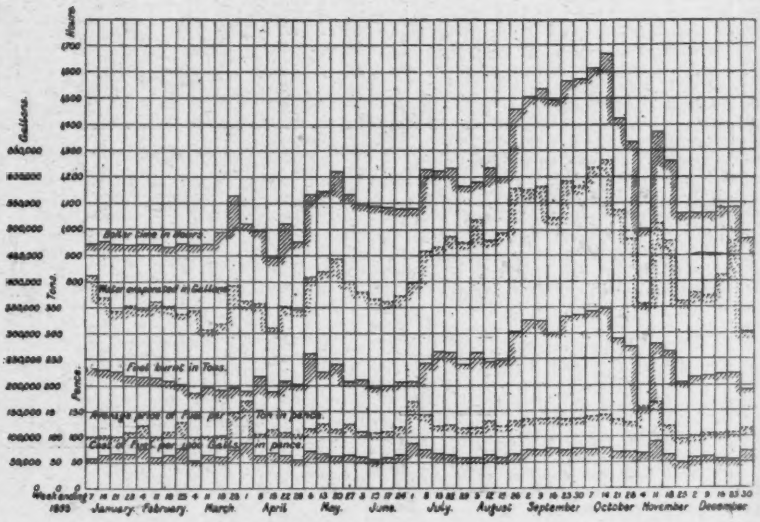


Diagram 3.

We have, therefore, two ranges of boilers, one using a cheap fuel and producing steam at a cost for fuel of 2s. 8½d. per 1,000 gallons evaporated at a rate equivalent to 170 H.P. per boiler, and the other producing steam at a cost for fuel of 6s. 9¾d. per 1,000 gallons evaporated at a rate equivalent to 190 H.P. per boiler.

We have now to consider the other items already mentioned, which go to make up the full cost of steam raising. The most important of these is working expenses, and in this labour is the heaviest. Under normal conditions seven boilers are under steam, viz., Nos. 1, 2 and 3 fired with breeze, and four of the other six fired with Welsh coal. As the boilers are worked continuously the firemen are divided into three shifts, of which the two day shifts work three spells of three hours each between 6 o'clock a.m. and 10 p.m., and the night shift one spell of eight hours; thus for two hours in the day both sets of the day men are in the house together, and in this time some of the necessary cleaning, &c., is done. There are generally three men per shift, the two leading men taking three and four boilers each, and the third man assisting each of them as required. Taking the amount burned in 24 hours as 15 tons of breeze and 18 tons of the Welsh coal, the total amount fired per day is 33 tons by the nine men, or an average of 3·67 tons per man per day, not an excessive quantity when compared with the new Board of Trade rule for ships which allows one stoker for every 4½ tons

Table IV.—Spare Boilers. Nos. 10, 11, 12, and 13.

Boiler.		Fuel.			Feed water.		Cost of fuel.	Working expenses.															
Date.	Time.	Coal.	Price per ton.	Refuse.	Evaporated.	Per hour per boiler.		Wages.			Fuel weighing and distribution.			Removal of refuse.			Light.			Water.			Stores.			Total.		
1895.	Boiler hours.	Tons.	s. d.	Tons.	Gallons.	Gals.	£ s. d.	£ s. d.			£ s. d.			£ s. d.			£ s. d.			£ s. d.			£ s. d.			£ s. d.		
Jan. ...	—	—	—	—	—	—	—	—			—			—			—			—			—			—		
Feb. ...	53	25	13 0	2·3	33,600	634	16 5 0	0	10	9	0	1	11	0	4	7	0	3	7	0	11	3	0	0	9	1	12	10
March	87	23	13 0	2·1	30,912	355	14 19 0	0	18	2	0	1	11	0	4	2	0	3	0	0	10	3	0	6	9	2	4	3
April ...	34	10	13 0	1·0	13,440	395	6 10 0	0	7	1	0	1	2	0	2	0	0	1	7	0	4	6	0	0	10	0	17	2
May ...	188	58	13 0	5·3	77,952	415	37 14 0	1	19	2	0	6	8	0	10	8	0	7	0	1	6	0	0	3	8	4	12	11
June ...	265	65	13 0	6·0	87,360	330	42 5 0	2	15	3	0	4	6	0	12	0	0	4	0	1	9	1	0	4	7	5	9	5
July ...	251	67	13 1	6·1	90,048	359	43 14 6	2	12	4	0	7	5	0	12	2	0	3	10	1	10	0	0	3	3	5	9	0
Aug. ...	683	188	13 0	17·3	252,672	370	122 4 0	7	2	5	0	19	5	1	14	8	0	11	10	4	4	3	0	2	6	14	15	1
Sept. ...	1,203	327	13 0	30·1	439,488	365	212 11 0	12	10	8	0	19	5	3	0	1	1	1	8	7	6	6	0	12	2	25	10	4
Oct. ...	1,115	284	13 0	26·5	387,072	347	187 16 4	11	12	4	1	10	4	2	13	0	0	18	8	6	9	0	1	7	11	24	11	3
Nov. ...	446	112	13 0¾	10·3	150,528	337	73 0 2	4	12	11	4	18	5	1	0	8	0	11	3	2	10	2	0	14	7	14	8	0
Dec. ..	—	—	—	—	—	—	—	—			—			—			—			—			—			—		
Aver'ges and Totals.	4,325	1,163	13 0⅛	107·0	1,563,072	361	756 9 0	45	1	1	9	10	9	10	14	0	4	6	5	26	1	0	3	17	0	99	10	3

TABLE V.—COSTS OF STEAM RAISING.

	Forced draught boilers. Water evaporated, 6,665,960 gallons.			Natural draught boilers. Water evaporated, 13,594,140 gallons.			Spare boilers. Water evaporated, 1,563,070 gallons.			All boilers. Water evaporated, 21,823,170 gallons.		
	—	Costs per annum.	Costs per 1,000 gals.	—	Costs per annum.	Costs per 1,000 gals.	—	Costs per annum.	Costs per 1,000 gals.	Costs per annum.		Costs per 1,000 gals.
	£ s. d.	£ s. d. Per cent.	s. d.	£ s. d.	£ s. d. Per cent.	s. d.	£ s. d.	£ s. d. Per cent.	s. d.	£ s. d. Per cent.		s. d.
Fuel bill	...	1,051 6 0 43·22	3 1·84	...	4,557 19 6 73·05	6 8·47	...	706 10 0 58·10	9 0·46	6,315 15 6 67·81		5 9·43
Other working expenses—												
Wages of stokers, &c.	277 7 6	... ...	...	288 12 6	... ...	...	45 1 1	... ...	...	... ...		...
Fuel receipt	23 8 2	... ...	...	38 19 4	... ...	...	9 10 9	... ...	...	... ...		...
Removal of refuse	120 6 0	... ...	...	79 6 0	... ...	...	10 14 0	... ...	...	... ...		...
Water	119 3 6	... ...	...	226 7 8	... ...	...	26 1 0	... ...	...	... ...		...
Light	16 6 10	... ...	...	27 7 2	... ...	...	4 6 5	... ...	...	... ...		...
Stores	16 19 2	573 11 2 23·58	1 8·65	13 11 6	674 4 2 10·79	0 11·90	3 17 0	99 10 3 8 18	1 3·28	1,347 5 7 14·44		1 2·82
Maintenances—												
Boilers and mountings	24 16 1	... ...	...	23 14 0	... ...	...	...	... ...	...	... ...		...
Furnaces and brickwork	21 7 0	... ...	...	36 7 6	... ...	...	...	... ...	...	... ...		...
Feed water heaters	4 9 11	... ...	...	8 9 8	... ...	...	...	... ...	...	... ...		...
Feed pumps	10 2 3	... ...	...	19 3 0	... ...	...	...	... ...	...	... ...		...
Fan and engine	3 7 9	... ...	...	...	... ...	...	...	... ...	...	... ...		...
Steam and feed mains	7 11 0	... ...	...	14 10 0	... ...	...	...	... ...	...	... ...		...
Non-conducting coverings	13 4 9	... ...	...	27 16 0	... ...	...	...	... ...	...	... ...		...
Sundries	4 1 0	88 19 9 3·66	0 3·20	7 14 11	137 5 1 2·20	0 2·42	...	30 15 9 2·52	0 3·84	257 0 7 2·76		0 2·82
Insurance—												
Boiler (explosion)	7 17 6	... ...	...	15 15 0	... ...	...	11 10 0	... ...	...	... ...		...
Boiler house and contents (Fire)	4 19 4	12 16 10 0·53	0 0·46	9 18 8	25 13 8 0·41	0 0·46	1 8 0	12 18 0 1·05	0 1·99	51 8 6 0·55		0 0·56
Interest on—												
First cost of boilers and machinery	113 0 0	... ...	...	149 0 0	... ...	...	100 0 0	... ...	...	... ...		...
First cost of boiler house and chimney	52 10 0	165 10 0 6·80	0 5·95	95 0 0	244 0 0 3·91	0 4·31	75 0 0	175 0 0 14·39	2 2·87	584 10 0 6·27		0 6·43
Depreciation—												
Boilers and machinery	113 0 0	... ...	...	149 0 0	... ...	...	100 0 0	... ...	...	... ...		...
Boiler house and contents	26 5 0	139 5 0 5·73	0 5·02	47 10 0	196 10 0 3·15	0 3·47	37 10 0	137 10 0 11·31	1 9·11	473 5 0 5·08		0 5·20
Ground rent	...	12 10 0 0·51	0 0·44	...	24 0 0 0·38	0 0·42	...	16 10 0 1·36	0 2·53	53 0 0 0·57		0 0·58
Rates and taxes	...	20 0 0 0·82	0 0·72	...	38 0 0 0·61	0 0·67	...	26 13 0 2·19	0 4·09	84 13 0 0·91		0 0·92
Superintendence	...	45 15 0 1·88	0 1·64	...	93 8 9 1·50	0 1·64	...	10 16 3 0·89	0 1·66	150 0 0 1·61		0 2·04
Share of cost of spare	...	322 14 11 13·27	0 11·62	...	249 4 6 4·00	0 4·40	...	... ...	...	... ...		...
Totals	...	2,432 8 8 100·00	7 3·54	...	6,240 5 8 100·00	9 2·12	...	1,216 3 3 100·00	15 5·83	9,316 18 2 100·00		8 6·80

burned per day; but the low quality of the fuel used on the Perret furnaces adds greatly to the labour of firing them, each of the six having to be cleaned out once in three hours or oftener. The firemen are paid at an average rate of 23s. per week, those working at night getting a shilling extra whilst doing so; they are under the charge of a foreman, who, however, has other duties to perform, so that a portion only of his time is charged against the boilers. A charge at the rate of £150 per annum is also made for the time which the engineer in charge devotes to this portion of his work. A boy is also employed for a portion of the day in the boiler house in sweeping the tops of the boilers, &c. The expense of weighing the coal, and any incidentals connected with its receipt over and above the price paid for it per ton delivered, is included in the working expenses; these being the same per ton for all qualities of fuels, constitute a heavier expense per 1,000 gallons of water evaporated by the inferior as compared with the better-class fuels.

During 16 hours, between 6 o'clock a.m. and 10 o'clock p.m., which constitute the only light portion of the week's work, two boilers are kept under easy steam, the fires in the other being cleaned quite out in the morning and started again at night. The firing during Sunday is done by three men working, two of them five hours and one six hours, for which they are allowed time and a half; whilst a second fireman works two or three hours in the evening as required, in order to re-start the boilers that have been at rest during the day.

Flue sweeping and boiler cleaning is the item next in importance. The boilers using the inferior fuel are very thoroughly cleaned out at the end of each 11 or 12 weeks' run, during which time they have generally steamed from 1,600 to 1,700 hours each, and have deposited in their flues a very large amount of dust which, but for the forced draught, would require to be removed much more frequently; as it is, there is certainly a falling off in the amount of water evaporated both per boiler and per pound of fuel burned, but not to such an extent as would justify the shutting down and cleaning of these three boilers five times a year instead of four as at present. This cleaning is performed not by the firemen, but by some of the general labourers attached to the concern; two men are able thoroughly to sweep and clean one boiler in four days, and in addition to their regular wages they are paid a gratuity of 12s. per boiler. In addition to the actual cleaning and removal of dust some expense is incurred in taking out fire bars, disconnecting air pipes, cleaning bars, &c., all of which are carefully overhauled at each periodic cleaning.

The natural draught boilers, fired with better-class coal, run for about the same length of time between cleanings as the forced draught ones, but as there are generally two of these idle, each boiler is cleaned only from three to four times a year; two men can finish a boiler in two days, and in addition to their wages of 5½d. per hour they earn between them the gratuity of 12s. for the job. Each cleaner is provided with a suit of overalls, which seldom serves for more than four boilers at the most. The expenses of cleaning out one of the natural draught boilers is far less than that of one of the forced draught boilers fired with inferior fuel.

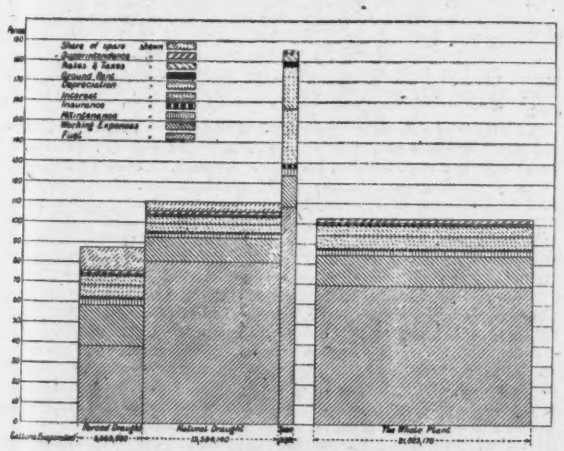


Diagram 4.

The removal of refuse, viz., clinkers and ashes taken from the furnaces in the ordinary way of firing, and the dust removed from the flues during sooting out, amounts to a considerable sum during the year; the bulk of it is removed from the premises by a contractor at a fixed rate per load, but since an intermediate handling is necessary, the removal of an average week's refuse from the forced draught boilers during work costs about £2, and the amount removed from the flues at each cleaning about 11s. 6d. per boiler; whilst that from the natural draught boilers is removed for 16s. 6d. per week whilst in full work, and 4s. 6d. per boiler cleaned.

The feed heaters being common to both groups of boilers, the cost of cleaning them and the feed pumps is taken according to the quantity of water evaporated in each group. The water used is taken from the town main, through meters, the cost being 4d. per 1,000 gallons; and as it is very pure, there is no expense incurred in treating it except for the addition of a small quantity of soda ash which is necessary to prevent corrosion.

The cost of illumination is divided amongst the boilers according to the number of boiler hours worked; gas and electric light are both used—the annual cost is about £50. In the same way also the cost of the steam used to drive the boiler feed pumps is divided according to the quantity pumped, but in the case of the forced draught boiler a further charge has to be made for the steam used by the fan engine in producing the forced draught. The quantity of fuel to be charged against feeding the boilers is, however, very small, as a very large portion of the heat in the exhaust steam is recovered by passing the exhaust into the low pressure main by which the feed water is heated. Some experiments have shown that by utilising the exhaust steam from the feed pumps to heat the feed water an economy of 1½ per cent. in fuel can be realised. There are two quadruple acting steam feed pumps, each capable of delivering one gallon per revolution, which also act as water meters, for which purpose they are fitted with counters which are read daily, whilst the pumps are calibrated periodically against a tank of known capacity to ensure correctness in the results; it is generally found that they deliver about 5 per cent. less than their full charge. A certain quantity of stores are of course used, such as shovels, firing-tools, barrows, soap, oil, waste, which in the course of a year amount to an appreciable sum.

The maintenance charges are somewhat more difficult to set out precisely for any given period than are the working expenses, as these vary from time to time, and a year is quite too short a period to ensure every item being fairly treated; some parts will come out too high or too low as repairs of any considerable extent happen to fall within or without the period under consideration. The figures given are those ascertained for the year 1895, and include somewhat heavy repairs to the pumps, and heavy items for renewals of non-conducting coverings of tops of boilers and steam mains; but in order to avoid errors the costs have been compared with those of previous years, and though the details differ, the totals agree very closely. The figures for maintenance are considerably less than they were expected to be when the investigation was taken up, but as the work was mostly done by the company's own workmen, only charges for labour and material are included; had the work been done by an outside firm, the figures must have been much higher, and the average cost of maintenance would probably have been 5 per cent. of the total, instead of less than 3 per cent. as they stand in Table IV.

The fixed charges include the insurance of the boilers against explosions at £2 12s. 6d. per boiler per annum, and it is worthy of remark what a very small proportion the cost of this excellent safeguard bears to the total cost of the steam made.

In calculating the interest on the first cost of the plant and buildings, it was found impossible to ascertain the actual figures, so a careful estimate was prepared on the basis of present prices, on which the interest has been taken at 5 per cent. per annum.

Depreciation of boilers and machinery has been taken at 5 per cent. per annum, and of buildings, including chimneys, at 2½ per cent.; ground rent, rates and taxes having been approximated to local conditions as far as possible, and superintendences in proportion to the amount of the steam made.

The question of spare plant is one of extreme difficulty, and the practice varies with each different case. In some instances, where an occasional stoppage is permissible, the amount of spare required may be *nil*; again, in cases where the boilers are worked by day only a small spare is allowable, because the interval between two days' work admits of minor repairs being carried out or temporary expedients resorted to. Where sufficient spare must be always available and the demand for steam small, then the spare plant must be fully equal to that in ordinary use; in other cases where the amount of steam made requires the use of several boilers, there is a point at which it is no longer necessary to maintain a full spare plant. In the case under notice it has been found that a spare plant of one boiler to every three in work is sufficient for all emergencies. This, of course, is based on the maximum and not on the average output of steam, consequently the spare plant has been comparatively very little used, but, as it exists, it has had to be kept in order, and it is a recognised fact that a boiler idle may deteriorate as fast as one in work; it has been kept in complete working order, and worked occasionally. Of course, the cost of steam produced by these independent boilers is much greater in almost every way, than that made in the main boiler house, as the statement in Table V. will show. The extra expenses of making this steam over and above those of that made in each of the two groups in the main boiler house have, in order to determine the full cost of the steam made in each, to be added to the ascertained expenses of those groups. It is, in the first place, difficult to decide what share of the expenses of the spare plant should be debited to each group of boilers in the main house, but, since the forced draught boilers were always worked when possible to their full fuel capacity, and had no self-contained spare as did the natural draught boilers, it has been considered right, in spite of their much smaller output of steam, to charge half of the extra cost of the spare to them, and the other half to the natural draught boilers.

The figures charged in Table V. as share of spare against the forced and natural draught boilers respectively have been determined thus: the quantity of water evaporated by the spare boilers is 1,563,000 gallons, at a cost of 15s. 5·8d. per 1,000 gallons; the difference in the cost of evaporating one-half of this, viz., 781,500 gallons at 15s. 5 8d., and the same quantity at 7s. 3 3d., the cost of the steam made in the forced draught boilers, amounts to £322 14s. 11d. or 11·62d. per 1,000 gallons on the quantity evaporated in the forced draught boilers. Similarly the difference in cost of evaporating 781,500 gallons at 15s. 5 8d. and the same quantity at provisionally 9s. 2 75d. amounts to £249 4s. 6d., or 4·4d. per 1,000 gallons on the quantity evaporated in the natural draught boilers. Even if this distribution of the extra cost of the steam made by the spare boilers be heavier than it should be on the forced draught boilers, the figures will, all the same, show that a too large spare plant may prove an expensive luxury, quite apart from the fact that, unless kept in good working

order and tried from time to time, it may fail in more ways than one when most required.

The author regrets that circumstances have compelled him to confine his observations to a type of boilers not so universal as was the case a few years ago, and which work at a pressure much below that now commonly used, but he ventures to hope that the figures may be of some use as a basis of comparison, and may, perhaps, elicit a more complete return from a thoroughly up-to-date plant.

In conclusion, the author would express his thanks to the officials of the company who have allowed him to use the figures, but who have expressed the wish that their names should not be made public.

INFLUENCE OF CHEAP FUELS ON THE COST OF ELECTRICAL ENERGY.

By R. E. Crompton, Past President.

(Paper read November 23rd, 1899.)

The problems involved in this subject are worthy of the careful thought and consideration of members of this Institution.

As water-power is only available in the United Kingdom to a very limited extent, the bulk of our experience in generating, transmitting and distributing power on a large scale is certain to be based on power stations put down in the best positions where we can either raise steam or work gas engines by means of our cheap fuels.

Mr. Holliday in his paper deals very exhaustively with several of the problems involved in dealing with inferior cokes or coals of the anthracitic description. My present paper must be taken as a suggestive one of other important problems connected with this subject, in the hope that the matter will be carried further by those of our members who are working as engineers-in-charge of electrical power stations, and who are therefore likely to have already directed their thoughts in this direction. Perhaps the first and most important point that we ought to consider is the extent of our available supplies of cheap fuel. I do not think that this most important point has been sufficiently looked into. I am told that in certain districts where fuel of very considerable calorific value could be had almost for nothing at the pit's mouth, solely because the difficulties in burning it were so considerable that no one had thought it worth while to put down proper appliances, immediately appliances were set to work to deal with this fuel on a large scale the price doubled itself. It is of considerable importance to take this into consideration, and then to fix on a price which is likely to hold good for a sufficient period. To enable us to discuss the problem I have put myself into communication with several colliery proprietors, and have ascertained that in the Midland district, Nottinghamshire, Derbyshire, and Yorkshire, there are supplies of slack coals available, the average price of which during the last 10 years has been about 2s. 6d. per ton at the pits, so that it could be delivered by railway carriage, including wagon hire, within an average radius of 50 miles for about 5s. 4d. per ton. At the present time, owing to exceptional demand, the present price is 1s. per ton higher than this, but I am informed that this higher price is not likely to be maintained, and that it would be fair to base my calculations on the assumption that a large supply of this coal would be available at the above price.

Whilst on this subject I must point out that railway rates and wagon hire are the same for inferior as for the best quality of fuels, so that this inferior fuel cannot be delivered to distant parts of the United Kingdom, such as in the case of our own works at Chelmsford, under 14s., so that it appears probable that it will rarely pay us to deal with these cheap fuels at an average radius in excess of 50 miles from the colliery.

Where a system of canal transport is available, as in the Birmingham district, these conditions will, of course, be modified, on account of the much lower rate for carriage and barge hire. From inquiries I have made, it is probable that the Cannock Chase class of slack may be delivered within an average radius of 50 miles from the colliery at about 5s. 6d.

There are three distinct classes of cheap fuels available for generating electrical energy. The first are those in which the calorific value is chiefly in the contained carbon. These include the anthracite and small Welsh coals, and the refuse coke fuels dealt with by Mr. Holliday. The difficulties in burning these fuels are not great. They are cheap, because they are friable, easily broken up by carriage into powder, and thus there is always loss in transit; such powdered fuel is liable to fall through the bars, or be carried forward in the form of dust into the flues and chimney. All easily pulverised fuel is also likely to have additional earthy matter mixed with it, as whenever a heap of it is shovelled over, the earthy bottom gets mixed with it, and thus its liability to form clinker is increased.

The second class of cheap fuel is the free-burning small coals of the Midland districts. In this class I include all the small and earthy coals which are only slightly bituminous, and which therefore have slight tendency to cake.

The third class is the small and dirty or earthy bituminous coals of the North. These last are the most difficult to deal with, but as they possess high calorific value the problem of dealing with them successfully is the most interesting of all.

The first group of fuels have been dealt with, with considerable success, by several forms of furnaces in addition to those described by Mr. Holliday. In this class it is all-important to reduce as far as possible the loss of unburnt fuel by its falling through the fire bars or being carried forward into the flues in an unconsumed condition. So far, probably, the best method of dealing with the clinker from this class is the provision of large water ash pans, the steam rising from which appears to have the effect of preventing the clinker from clinging to the bars. A great portion of it separates as it forms into small drops of melted matter and falls through the bars into the water instead of forming large cakes which hinder the air admission.

Up to the present the attempts to satisfactorily deal with the second and third classes of fuels have been chiefly connected with the use of automatic appliances for distributing the fuel over the bars, breaking up and getting rid of the clinker, and providing sufficient admixture of air at various points in the furnace to insure satisfactory combustion of the gases. These last difficulties are at their greatest where a great portion of the calorific value of the fuel lies in its volatilisable products.

I think that most of those who have had experience in the use of automatic stokers will agree with me that, although in some cases where a large range of boilers has been automatically fired, economies in labour have undoubtedly followed, yet the cost of clinkering the grates and afterwards removing the clinker from the boiler room and the cost of maintenance of the grates and furnaces has been so considerable, and these difficulties and costs increase so rapidly with the amount of ash present in the fuel, that in most cases even with these automatic stokers it has been advisable not to use the very cheapest class.

With the third, or highly bituminous class, coking stokers have been used with more or less success. Most of these operate on the principle of spreading the coal on the front end of the grate, allowing it sufficient time to form itself into coke, and then by means of moving bars to break up and move this coke forward over the bars to the point where intense combustion and radiation is required. This method is correct in theory, but it has not worked out well in practice. The moving bars do not move the caked material forward with sufficient regularity, so that openings occur in the fire, and thus excess of air is allowed to dilute the gaseous heated products of combustion, and their temperature is thereby reduced. Clinker is seldom automatically got rid of, and in most cases a considerable amount of hand labour has to be expended on its loosening and removal.

From the above remarks it will be seen that one great difficulty in burning cheap fuels at a small cost for labour and maintenance is that of getting rid of the clinker. What we require is that the fuel should be tipped from the railway trucks or barges into conveyers, and thence distributed to the furnaces without being touched by the firemen, and that after passing through the furnace the clinker and ashes should also be automatically taken away from the back of the furnaces and delivered into a railway truck without any hand labour being necessary.

There are two distinct methods of dealing with the cheap fuels which contain much volatilisable matter. The first is that described very fully in a paper read on March 16th, 1897, by Mr. Humphrey (*vide Min. Proc. Inst. C.E.*, Vol. cxxix., p. 190) before the Institution of Civil Engineers on the "Mond Gas Producer." With this system the fuel is gasified in separate gas producers, and the gas then burnt under boilers or used in gas engines. I do not propose to deal with this system, although it may well be a most satisfactory way of utilising cheap fuels, as it has been most thoroughly described by Mr. H. A. Humphrey in his paper. He showed that by this method 90 lbs. of sulphate of ammonia, which is about 70 per cent. of the total nitrogen in the fuel, may be recovered from it, and that the gas from each ton of coal is then capable, under ordinary boilers, of evaporating not less than 7 tons of water. The repairs and upkeep of the system appear to be satisfactorily low.

I propose for the present to confine my remarks to suggestions as to the form of furnace which may be attached direct to the boilers to burn these inferior fuels so as to evaporate the water at the least cost.

Mr. Holliday has called our attention to the fact that in considering such furnaces and the boilers best suited to them, the use of cheap fuel has undoubtedly, up to the present, necessitated the use of larger furnaces and larger boiler plant, so that there has been considerable increase in the capital cost, and hence in the maintenance charges, which are a percentage of that cost, and this, of course, increases the real cost per 1,000 gallons of water evaporated. I think, however, that in the case of externally fired boilers, at any rate, arrangements may be suggested by which the grate area only need be increased, the size of the boiler remaining the same as for the best fuel; for if we so arrange our grate that those portions of it in which the preliminary work of igniting and caking the fuel is performed are at a comparatively low temperature, this portion of the grate or furnace may be exterior to the boiler, and it follows that that portion of the furnace in which advanced combustion is carried on would be no larger than would be the case if we were burning the very best Welsh coal; but it is only fair to say that in the case of bituminous fuels where it is necessary to prevent newly formed volatilisable products from coming into contact with the cold boiler surfaces considerable additional space will have to be provided exterior to the boiler itself, as it is evident that in this case, in order to produce perfect combustion of these products, some form of combustion chamber which contains a large surface of highly incandescent material must be provided. Again, however carefully we may provide for the disposal of the clinker, portions of it are certain to adhere to the bars and lining of the furnace or combustion chambers, and in order that these parts may be made easily accessible for cleaning, the whole furnace ought to be easily removable from the boiler—in other words, it should be built on a frame mounted on wheels running on rails.

Probably the simplest and most efficient method that has yet been contrived of continuously firing a large grate with cheap fuel is by the old Juckes revolving grate, which has been in use for upwards of 30 years, and wherever it has been properly installed and well mounted has given satisfactory results. I remember seeing one of these grates in use in Messrs. Fowler's works at Leeds in 1871—that is to say, 28 years ago—and I am told that the performance has been so continuously satisfactory that Messrs. Fowler are still using this form of grate.

It appears probable that all the conditions I have above noticed

could be satisfactorily filled up by a revolving grate mounted on a movable frame running on rails. In these days of electric motors there is no difficulty in providing power for working this grate. It can easily be constructed to deliver the clinker and ashes continuously into a transverse channel at the back end of the grate, from whence it could be removed by a conveyer to suitable trucks. Immediately above that part of the grate on which the fuel is ignited I propose to provide a combustion chamber in the form of a long bridge made of a special quality of fire brick. I have found by experiment that a good way of arranging this apparatus is in the form of an extended fire brick arch, each arch-shaped brick having a fin-like projection hanging down from its lower surface into the path of the gases. I have already used this form of combustion chamber for Lancashire boilers at our works at Chelmsford with satisfactory results. The extended surface of fire brick acts extremely well as a reservoir of heat even under the difficult circumstances of firing a Lancashire boiler, the fire door of which must be frequently opened, but it is evident that this form of bridge will work much more efficiently in an automatically, and hence continuously, fired boiler where no necessity exists for so often opening the door and hence admitting cold air. As I have pointed out above, for burning the first group of cheap fuels this regenerative apparatus may be dispensed with. It is somewhat more necessary in the case of the second group, but it is absolutely necessary in the case of the bituminous smoky fuels of the third group.

Up to the present the weak point of smoke-consuming apparatus has been that it has generally stopped short at supplying additional air so as to obtain more perfect combustion of the fuel, and although this has resulted in a larger proportion of the CO being converted into CO_2, yet as this has been effected by passing a considerable excess of air through the furnace, the heated products have been so diluted and cooled that not only is the output of the boiler diminished, but also its efficiency greatly reduced. The only satisfactory method of dealing with the question is to provide the combustion chamber I have above described. I need hardly remind those who are accustomed to boiler tests that the efficiency of a boiler is largely proportionate to the proportion of CO_2 present in the gases as they leave the furnace. On tests we always try to get this proportion as high as possible. In my experiments at Chelmsford, I have been able when my combustion chambers were worked successfully, and when using highly bituminous fuel, to bring the proportion of CO_2 up to 11 per cent., which is sufficient proof that a very small excess of air was passing, and that the products were consequently undiluted.

How important it is that the excess of air should be kept down is shown by the following table:—

	Test of water-tube boiler at St. Pancras.		Test of water-tube boiler at Glasgow.		Result of the Glasgow test if excess of air had been prevented.	
	B.T.U.	Per cent.	B.T.U.	Per cent.	B.T.U.	Per cent.
Heat transferred to water	10,463	72·6	8,228	68	9,960	83
Heat carried off with products of combustion and excess air	1,792	12·4	2,959	25·25	1,440	12
Heat in unburnt fuel mixed with ashes	316	2·2	417	3·45	240	2
Heat radiated and otherwise unaccounted for	1,829	12·7	390	3·22	360	3
B.T.U. in fuel ...	14,400	100	12,012	100	12,000	100

In column 1 I give the figures of an often-quoted test made with a water-tube boiler using the best Welsh coal, hand-fired. In this case only about 12·5 per cent. of the heat was carried off with the products of combustion and excess air. Owing probably to considerable radiation losses the efficiency of the boiler in this case was not extremely high, being under 73 per cent. In column 2 I give the results of a test made at Glasgow with a water-tube boiler, coal having a calorific value of 12,000 B.T.U., being fired by automatic stoking apparatus. From the inefficient working of this apparatus it was found difficult to keep the bars properly and evenly covered, so that what otherwise would have been an extremely good result was spoilt, as the heat losses due to heat carried off with the products of combustion and by excess air were over 25 per cent., so that the total efficiency therefore worked out at only 68 per cent. In column 3 I give the results that ought to have been obtained at this test with automatic stoking of this class of fuel if this excess of air had been properly controlled.

Since I commenced the preparation of this paper I have learnt that the Babcock & Wilcox Company, who have already done so much to reduce the cost of steam raising, have actually perfected and brought into practical use a form of furnace which combines a considerable number of the requirements that I have laid down in this paper as necessary for the satisfactory and economical burning of cheap fuels. In the Babcock & Wilcox new revolving grate, illustrations of which I am able to put before you on the screen, it will be seen that they provide a modern revolving grate which performs the duties of feeding the fuel on to the front of the grate and delivering the ashes and clinker at the back of the grate in a most satisfactory manner. The whole grate is mounted on a removable frame running on rails, so that it can be removed from the furnace and ready access given to the parts for examination, renewal, or repair. The difficulty of getting rid of the clinker and ashes at the back of the grate without admitting air at this point was a matter in which the old Juckes grate was defective. This is got over by means of a very heavy cast-iron flap which rests on the revolving bars at their back end. The bars have to move forward under this flap, and as it has a sharp edge the clinker and ashes are removed from the bars, slide over its inclined surface, and are delivered into an air-tight receptacle at the back from whence they can be removed by a conveyer or other convenient means. It is probable that this revolving furnace is a great step in advance, and probably the only addition that is required to perfect it is the addition of the combustion chamber which I have described.

In order to show the proportion the cost of fuel bears to the total cost of generating energy in a modern power station of moderate size I have extracted figures from the log book of the power station of our new Chelmsford works, from which I have prepared the accompanying table, which shows that under the actual conditions of working the plant during the last 49 weeks, and at an average price of 17s. 5d. per ton of coal (which was Nottinghamshire steam hard of the best quality), the cost of the fuel was 64 per cent. of the total cost of 0·77d. per B.O.T. unit delivered to the tools. The plant is of moderate size; including spares its maximum rate of output at present is about 250 KW. It is not easy to give the average rate at which it is worked, but it is probable that this is at the rate of about 120 KW. during 54 hours per week and 50 KW. during the night shift during 62 hours per week. If the plant had been worked at the higher rate throughout the night as well as the day shift, the output would have been increased from 368,000 B.O.T. units to 680,000 B.O.T. units, and the cost prices would have been modified as shown in the second column—that is to say, that the cost of coal would then have been about 76 per cent. of the total cost, which would stand at 0·63d. per unit. If, however, this plant were put to work within the radius of 50 miles from collieries, where cheap coal at 5s. 4d. per ton could be supplied, and the furnaces of the boilers modified to suit this fuel in the manner I have indicated, the figures in the third column would be obtained at the rate of output in column 1, and those in the fourth column at the rate of output in column 2, and it must be observed that in these two columns I have not reduced the cost of labour to the extent that might fairly be claimed by the saving in stokers' wages.

It is needless for me to point out to you that increasing the size of this plant would largely reduce the labour charge, so that it is probable that (exclusive of interest and depreciation) the total cost price of ¼d. per unit would be reached in many cases, providing that the coal obtainable at 5s. 4d. per ton is burnt in a satisfactory manner. The fact that such figures are now easily within reach ought to be a powerful stimulus to the investment of capital in power distribution works.

Table Showing the Proportion which the Cost of Fuel Bears to the Total Cost in Chelmsford New Works Power Station.

	(1)	(2)	(3)	(4)
	Actual cost per B.O.T. unit at output of 368,000 units in 49 weeks.	Calculated cost if full night shift be worked, giving 680,000 units in same period.	Cost as in col. 1 if coal 5s. 4d. per ton were available.	Cost as in col. 2 if coal at 5s. 4d. per ton were available.
	d.	d.	d.	d.
Coal at 17s. 5d. per ton delivered at boilers	0·488	0·480	0·15	0·148
Stores	0·0293	0·016	0·0·93	0·0·6
Labour, superintendence, two complete shifts, including flue and boiler cleaning	0·236	0·127	0·236	0·127
Repairs	0·016	0·0·9	0·016	0·009
Total	0·769	0·632	0·431	0·300
Coal to total cost ..	64 %	76 %	35 %	49 %

PHYSICAL SOCIETY.

Ordinary Meeting held November 24th, 1899.

Prof. G. Carey Foster, F.R.S., Vice-President, in the Chair.

A paper "On the Conductivities of Certain Heterogeneous Media for a Steady Flux having a Potential," was read by Dr. C. H. Lees.

Two formulæ have already been proposed to express the conductivity of a mixture in terms of the conductivities of its constituents. In the first formula the conductivity is represented as the

sum of a number of terms, each one of which is the product of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. In the second formula, the resistivity of a mixture is expressed in the same way with respect to the resistivities and percentages of its constituents. In general the first of these suppositions gives results which are above the experimental values, while the second gives results which are below. If we suppose that the mixture is made up of a series of columns of the separate parts stretching normally between two equipotential surfaces then the conductivity would be accurately represented by the first formula. If, however, we assume that the constituents are arranged in parallel layers then the second formula would apply. In the present paper the author has attacked the problem two-dimensionally and has investigated the relation which holds between the conductivities, when the constituents are arranged in the mixture, alternately like the squares on a draughtboard. Dealing first with two components it is easily shown that the problem reduces itself to finding the form of the equipotential curves and of the stream lines in a square which is divided by a diagonal into two parts of different material. By means of conformal representation Dr. Lees has referred the square under consideration to a kite-shaped quadrilateral with two opposite angles (right angles), and the other two to determined by the conductivities of the constituents as to give straight equipotential lines in the two portions of the figure which represent the two materials, and which are separated the one from the other by the axis of symmetry. The general relation which exists between the vector co-ordinates in the two systems has been proved by Love to consist of elliptic functions, but near the angular points of the figures a close approximation can be obtained by the use of a simple exponential expression. Taking the known solution to the problem in the case of the kite-shaped quadrilateral it is easy to calculate the result for the square under consideration. This leads to the conclusion that the conductivity of the square is the geometric mean of the conductivities of the constituents. Allowing the medium to become fine grained, and introducing new materials, it follows at once that the logarithm of the conductivity of a mixture is equal to the sum of a number of terms, each one of which is the product of the logarithm of the conductivity of any constituent, and the fractional part of the mixture which is made up of that constituent. By a superposition of fluxes the author has shown that the above law holds for flows in four directions, and he, therefore, considers that with the assumed structure the formula represents the conductivity for any flux.

Dr. Lees then read a second paper "On the Thermal Conductivities of Mixtures and their Constituents."

In this paper the three formulæ considered in the preceding communication are applied to the known experimental results upon the conductivities of mixtures of liquids. The author finds that the least satisfactory formula is the first one, whereas the least unsatisfactory is the logarithmic one.

Mr. Appleyard said that it was frequently of importance to be able to determine the resistance of a mixture of gutta-percha from the known resistances of component parts. He had attempted, without success, to do this by means of the old formulæ, and he would be interested to see whether Dr. Lees' logarithmic formula gave better results. In electrical work, Mr. Appleyard pointed out that the nature of the contacts affected the conductivity, the resistance of a sheet of rubber being different when measured between metal plates and mercury sheets.

Mr. Campbell said that the difference between the calculated and observed results might be due to the thermo-electric properties of the materials. Lord Rayleigh had observed that the high resistivity of alloys might be due to a back E.M.F. produced by the contact of dissimilar metals. Mr. Campbell said that he had measured the resistances of ferro-nickels, both with direct and alternating currents and found them the same in the two cases.

In reply, Dr. Lees said that all his experimental work on conductivity had been carried out with mercury contacts.

The Society then adjourned until December 8th, when, by the invitation of Prof. S. P. Thompson, the meeting will be held in the Physical Laboratory of the Finsbury Technical College.

CARE OF CAR EQUIPMENT.

At the Chicago convention Mr. Vanderveer, of the Brooklyn Heights Railroad Company, gave his views on the care of car equipment. In the first place, only those equipments fitted with both oil and grease boxes will safely run over 40 days without thorough overhaul. For overhauling purposes, there should be extra trucks with motors mounted ready to be run under car bodies as these are lifted off their trucks. For this purpose four duplex chain hoists are necessary, or air hoists, with cross timbers and stirrup irons. This lifts a car body with little injury, the truck is run out, and the spare one substituted all in about one hour, for which time alone the service of the car body is lost. On opening the motor case, the armature should be removed to a rack for test and cleaning. The fields, also, must be tested for drop, and where this is present those fields and armatures should be used together, new and re-wound fields and armatures, also, being kept together with resulting durability and less risk of crippled cars on the road. Motor cases are cleaned with compressed air or washed with kerosene; grease is removed from the boxes and put into gear cases, and the grease boxes cleaned with kerosene. At the same time the whole truck is inspected. A car will run five days safely between general inspection, and one man will, in this way, take care of 20 to 25 cars per day. As regards the trolleys and poles, another man will look after all circuits, canopy switches, fuse boxes and arresters. A third will be fully occupied with the controllers, while the brakeman and assistant will keep the brakes in order on this number of cars.

Night work should be limited; three men by night are sufficient to take care of 100 cars, greasing motors, inspecting brushes, and doing small trolley repairs. All car washing should be day work, night cleaning being limited to dusting and sweeping out.

A shed of 100 cars requires one good carpenter, and no car that requires more than a day's work to repair it after a collision, &c., should be done out of the general repairs shop, to which every car should go at least once a year. It pays for companies to make their own electrical repairs, including making armature coils and renewing commutators, which is best done by sawing off lengths from bars of hard drawn copper. It is suggested to make the diameter as much bigger than manufacturers' sizes as the brush holders will permit. For controllers and canopy switches the parts can best be purchased and assembled.

Piecework has been found by the author to be applicable to body repairs, painting, armature winding, making commutators and coils. In a case known to him, cars were costing £24 to re-model on day work. They were then let out to four men to do for £22, and these four men did the work easily and earned 24s. per week upon their previous rate of 9s. per day. The price is now cut down to £16 per car, and the men are earning 10s. daily, but close inspection is necessary—we believe it; they must have been pretty bad skulkers in the old days, or they must now be very tired o'nights.

In discussing this paper, Mr. Conette, of Nashville, stated that he followed steam railroad methods, and ran a car 100 to 200 miles, and then into the shed, where it was cleaned and inspected ready to start next day. With limited equipment it is necessary to work by night, general overhaul being done by the day gangs. As regards spare cars, about 10 per cent. is an outside requirement for double motor equipment. Single motor equipments run higher than 10 per cent., and Mr. Foster, of Lynn, stated that it did not pay to run single equipment, while he found that an open 10-bench car, with a pair of G.E. 57 motors of 52 H.P. each, ran all summer at 120 miles per day without any repairs being necessary. He advises large motors to reduce repairs. Single motors, however, have been found in Nashville to require less power than double equipments, but are short of adhesion especially if run uphill with motor axle leading.

It would appear that roads should make their own trolley wheels, though one speaker dissented if wheels could be bought for 11½d. per pound, and sold for scrap at 8d. This man used a 5-inch wheel, weighing 3½ lbs. finished. Why do not various lines combine to run a small brass foundry on mutual terms? The dissenter, however, makes contracts for 5,000 wheels at once, to be delivered as needed, and the shop making them can always do so, as a filling-up job in time that otherwise might be partly wasted.

The same gentleman also believes that the power saved by single motor equipment is saved at great cost in repairs, for the energy used is one of the cheapest things put into a road. Even on his double-truck cars he now uses four motors, and by this can make rapid starts and good time. While such cars may consume 30 per cent. extra power, they are really the cheapest in the long run. The motors are G.E. 1,000, one on each axle. Flats are reduced to a minimum, and maintenance alone is reduced a fourth below that for two motors. The cars seat 44 passengers, and are 41 feet long overall. They average 8½ miles per hour, and run at long headways, but punctually. A car makes 160 to 170 miles daily as a minimum, and on interurban service as high as 380 miles. This is in Milwaukee, where rates of 50 miles an hour are run on portions of the line which are on private right of way.

Another speaker detailed how he had spliced his 16-feet car bodies and placed them upon double trucks, and on level track they run as fast as the old cars with the same 25 H.P. motors. It costs about £60 to £80 to splice a couple of cars. Trolley wheels average on one line 8,000 to 9,000 miles, though some roads get 16,000 miles. The 8,000 mile wheels are 86 per cent. copper, 8 to 9 of tin, and 4 to 5 of zinc. Steel wheels wear the trolley wire. On all points raised, especially as regards single and double equipment, and cars generally, there was great difference of opinion, as may be expected, from men on lines working under widely varying conditions. The impression conveyed as a whole is, that the car of the future will be one with double trucks, and, possibly, four motors.

STANDARDISING IN ENGINEERING CONSTRUCTION.

Much has been said as to the lowering effect on the workman of repetition work. Americans, of course, who have as manufacturers been so very successful as our competitors solely because they have worked along repetition and standardising lines to a very full extent, do not agree with the above, but then the American manufacturer is necessarily biassed in favour of the system, and may perhaps be excused if he sees none too clearly that what is to his profit may be to his workmen's injury. Our own observation in this country tends, however, to the same conclusion.

For many years the production of textile machinery has been conducted on the fullest lines of repetition, and there is a marked difference between the men employed in a machine shop and the men in large engine works; here repetition work is less pronounced, and

there are wide differences between one engine and another and considerable scope for a more intelligent individuality. But even here may there not be a confusion of cause and effect? Possibly it may be that the better work has demanded better men, and that the inferior men have drifted naturally to the less intellectual work of the machine shops. The subject admits of endless *pro* and *con* arguments. Sir Benjamin C. Browne, who writes on standardising in the *Engineering Magazine*, denies the lowering effect of repetition work, but he adduces a very poor argument to support his contention, to wit, that greater intellect is required to *organise* an economical system of standard reproduction, to carry it on, &c., than is required to do an isolated piece of good work. His argument, however, is useless. It is not the man who is the repetition worker that does the organising, but one of superior intelligence, who has perhaps never even handled a tool, whereas the isolated pieces of good work are done by manual workers.

It is because the scheming of repetition work is done by superior intellects that the mere machine tending is so unintellectual a process. Let us take only one instance in such work, say, the rough turning of a spring barrel or some other part in a watch. The turner has supplied to him the pressed casing or stamping in the rough. He has to fix it in the lathe. For this purpose there is a chuck on the lathe spindle, and the machinist is not even called upon to use any intelligence in gripping the piece. The chuck does this for him, not only correctly as to position, but as to force of grip. The machinist may be a fool, but the chuck will not distort the piece, for it is only tightened up by a handwheel which has a slip motion and refuses to grip harder than it has been set by the superior intelligence of some foreman. The actual work of turning or boring is performed by tools that have been fixed by the superior intelligence, the machinist merely pulls handles and forces the tools to their work. He can only pull the handles as far as some stop piece, also fixed for him by the intelligence department. His own share consists of mere repetition work. If he be a man he can be equalled or surpassed by his son or daughter in rapidity, and though he may have to keep his wits about him, as Sir Benjamin says, we cannot think that this amounts to a particularly intellectual use of his wits.

Far be it from us to stamp the man himself as unintelligent. Thousands of men, by the stress of environment and the very fact that they possess intellectual faculties of a high order, useless to them for purposes of gain, are compelled to resort to the meanest of employments for the purpose of gaining food and clothing. Such men no doubt find employment for their intellects in apparently useless hobbies, and occasionally come to the surface as learned in some special point of geology or botany, and if the majority of machine workers could be educated to science there would be some set back to the demoralising effect of mere mechanical labour. This ameliorating influence is at present absent from American work. Hours are too long—far too long for closely applied drudgery, and must inevitably be shortened as soon as American workmen discover the better hours in England and Australasia and become more homogeneous where they are now divided into narrow circles of different nationalities. The only hope we see for the future worker is in the line of intellectual employment of leisure hours. As regards success in manufacturing, it is, of course, hardly necessary to insist that repetition and standardising are necessary to success in manufacture. But there may be a limit which it is not good to exceed in rapidity of production. American manufacturers have had but one end in front of them—rapidity of production. That this is so is more and more apparent every day. The tool maker rules the roost. He it is that makes out the calculations as to the rates of cutting and performance. He it is pickles castings to reduce their surface hardness and ease his tool, and it is to him that manufacturers of soft steel are indebted for the demand for this material, the absence of which, in Europe, so arouses his wrath. It is usually claimed to be a proof of American prowess, that in England American tools will not do the work they do regularly at home, but the truth is, that the difference is one of materials. Material suited to rapid machine work is good in very many directions, but more especially in small machinery. The wearing surfaces of a light sewing machine are so excessive as compared with the proportions of a steam engine, that soft materials do not show to disadvantage. But undue softness of material may be carried too far, and we think American manufacturers would be well advised to look into such matters otherwise than through the spectacles of the man who supplies, shall we say, for a good example, the machine on which they bore steam engine cylinders. The end and aim of a steam engine cylinder is not to be rushed through a boring mill. "As hard as can be bored" conveys a very different idea to an engine manufacturer in America from what it does in England. Perhaps too much stress is laid on durability in English work. Durability tempts the owner of a tool or other machine to continue it in use after it has been superseded by an improved tool. To scrap a tool as good as new is felt to be a waste. To read articles like this of Sir Benjamin Browne's is good for a man, because it opens up the lines of thought on which other men are working, but we observe that all these articles on competition assume that America has the monopoly of the system of standard and repetition work. Now this idea must be carefully guarded against.

We believe there is no shop in America where modern manufacture is carried out so perfectly as by Willans & Robinson, to name one well-known firm, while for the best work, despite all croakers, and we shall not cease to croak ourselves while so many abuses exist, England still leads. We have many things to remedy and abuses to correct, but these are excrescences merely. An engine building firm have informed us since the above was written that they are driving their machine tools to take heavier cuts, and generally to do more work than they can even get Americans to believe possible. Yet no one hears of this firm except as a maker of very good engines.

The whole question of modern conditions of manufacture cannot be dismissed by the off-hand assertions and claims of either the tool maker or the manufacturer. The workers have claims. It may not appeal to the employers to consider these, but it will be impossible to avoid doing so. For the present the just claims of labour have been so ground up with their unjust claims at the hands of selfish and unscrupulous leaders, that great harm has been done to everyone. Our own idea of manufacturing is that the function of machinery is to increase production, and to reduce the cost of everything, and to compel labour to put forth its energies under high pressure for short hours. At the moment America, which is using up the stamina of its people by high pressure and long hours, really stands as the principal obstacle to a more enlightened social system.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

22,597. "A locking device for electric incandescent lamps." G. W. Goldring. Dated November 13th.

22,615. "An improved safety device for starting switches of electric motors." A. J. Atterberg. Dated November 13th. (Complete.)

22,660. "A new or improved method of preventing or diminishing sparking on breaking electric circuits and apparatus therefor." L. W. Heath. Dated November 14th.

22,662. "An improved joint for troughs for electric cables." A. E. Tanner. Dated November 14th.

22,666. "A new or improved chemical generator of electricity." E. L. Anderson. Dated November 14th. (Complete.)

22,679. "Electro-magnetic appliances." J. L. Cutler. Dated November 14th. (Complete.)

22,702. "Improvements in or relating to electric motors." A. J. Boult. (O. Patin, France.) Dated November 14th.

22,707. "Improvements in the distribution of electricity." A. Sweet. Dated November 14th.

22,710. "Improvements in apparatus for the electrolytic extraction of zinc." H. H. Lake. (S. Stepanov, Russia.) Dated November 14th. (Complete.)

22,754. "Improvements in or connected with alternating arc lamps." W. J. Davy. Dated November 14th.

22,757. "Improvements in electro-magnetic reciprocating engines." W. H. Willson and M. S. Conly. Dated November 15th.

22,762. "Improvements in electrical switchboards." E. W. Cowan. Dated November 15th.

22,784. "Improvements in telephones." D. Macdonald. Dated November 15th.

22,785. "A tinted film covering an electric lamp." F. Round. Dated November 15th.

22,807. "Improved manufacture of lead peroxide and its application to electrical storage batteries." H. Beckmann. Dated November 15th.

22,809. "Improved manufacture of magnet cores with ventilating passages for transformers and the like." O. T. Blathy. Dated November 15th. (Complete.)

22,829. "A material or composition suitable for electric battery cases, insulating and other purposes and method of manufacturing the same." Phelp's Metal Limited. (C. J. Hubbell, United States.) Dated November 15th.

22,880. "Improvements in primary batteries." S. Robinson, (S. R. B. Robinson, United States.) Dated November 15th.

22,882. "Improvements in batteries for the generation of ozone and for like purposes." C. A. Sahlstrom. Dated November 15th.

22,883. "Improvements in electro-magnetic coils and magnets." J. Jones. Dated November 16th.

22,887. "A medicinal light-curative apparatus for the production of complete or partial baths of chemical and electrical rays of light." L. Cunow. Dated November 16th. (Complete.)

22,889. "Improvements in or relating to trolleys for electric tramways and the like." W. R. Ormandy and J. Unsworth. Dated November 16th.

22,900. "Improvements in magnetic cut-out apparatus." L. Andrews. Dated November 16th.

22,919. "Improvements in insulators for electrical purposes and method of making same." S. W. Johnson. Dated November 17th.

22,960. "Improvements in electric insulating devices." H. H. Lake. (L. McCarthy, United States.) Dated November 17th (Complete.)

22,964. "A new or improved electric automotor carriage." P. Hebert and E. Cannevel. Dated November 17th.

22,989. "Improvements in electric tramways or railways." F. Hewer. Dated November 18th.

23,009. "Improvements in automatic electric warning signals for railways and the like." J. H. Hollyer. Dated November 18th.

23,021. "Improvements in or relating to electric motor vehicles." H. Sefton-Jones (of the firm of W. P. Thompson & Co.). (Kölner Accumulatoren-Werke Gottfried Hagen, Germany.) Dated November 18th. (Complete.)

23,029. "Improvements in or relating to electrical traction, particularly applicable for tramways and railways." H. Lane. Dated November 18th.

23,033. "Improvements in secondary batteries." W. Scholthauer. Dated November 18th.

23,040. "Improvements in or relating to apparatus for the electrolysis of alkali chloride solutions." A. J. Boult. (F. Störmer, Germany.) Dated November 18th. (Complete.)

23,047. "Improvements in radio-conductor tubes." E. Ducretet. Dated November 18th. (Complete.)

23,054. "Improvements in coupling appliances for the electrical conductors of electrical railway and tramway vehicles." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated November 18th.

23,055. "Improvements in current collecting apparatus for the underground conductors of electric railways and tramways." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated November 18th. (Complete.)

ELECTRICAL PATENTS OF 1885 EXPIRING IN NOVEMBER AND DECEMBER, 1899.

We are informed by W. P. Thompson & Co. that about 180 applications for electrical patents were filed in November and December, 1885, of these some were never completed, and of those that were, only four have been maintained to run their full term, viz., 14 years; these being of considerable interest we give a short abstract of them below:—

13,207. "An improved manufacture of metal wire for electrical transmission and other purposes." E. Martin. Dated November 2nd, 1885. Relates to conductors. Compound wire for use as electric conductors is composed of two metals or alloys of different strength and conducting power enclosed one within the other and drawn down to the required gauge. 1 claim.

15,251. "Improved means for distributing electric energy." S. Z. de Ferranti. Dated December 11th, 1885. Relates to cables. In a special system of distributing electricity for lighting, the mains for conveying the current consist of two concentric metallic tubes with insulating material between. If the conductors are suspended from steel wires, they may be enclosed with the steel wire in a woven or other fibrous tube. 10 claims.

15,858. "Improvements in electric switches." B. M. Drake and J. M. Gorham. Dated December 19th, 1885. Switches are constructed with contact blocks of one or two or more concentric springs cut on one side to admit of the end of the lever. Bolts are employed to tighten the contacts when necessary. 4 claims.

15,986. "Improvements in the means of and apparatus for the extraction of metals from their ores; particularly in the treatment of 'blue stone' and similar complex ores, and for electrolytically refining copper and for the manufacture of sulphuric acid by electrolytic action." W. Elmore, A. S. Elmore, and H. Barrett. Dated December 29th, 1885. Relates to a method of treating complex ores, and the object is to extract and refine the metals and to manufacture sulphuric acid by electrolytic action. The finely ground ore is roasted in a reverberatory furnace and while hot stirred in a tank with water or other suitable solvent for dissolving zinc and copper. The solution is removed to a tank containing zinc to precipitate the copper and any silver present, and the precipitate is fused to form an anode in subsequent operation. The zinc left in solution is deposited by electrolysis, and the acid liquor obtained is passed over fresh ore. The residue, which may contain lead, gold, silver, &c., is smelted for lead, which alloys with the gold and silver and may be treated in the usual manner. The copper-silver alloy or other like alloy is refined as follows:—The alloy is made the anode of an electrolytic apparatus, consisting of a tank divided by a porous partition. Both cells are partially filled with a solution of cuprous chloride; the liquid in the cell containing the anode is kept at a lower level by means of an adjustable overflow. On passing a current through, part of the copper is deposited at the cathode, while the remainder, together with the silver, is dissolved. The solution is treated with an iodide to separate the silver, and then passed back to the tank to be re-charged. The sulphurous fumes given off in calcining are, together with steam, passed into a chamber, through which electric discharges pass between conductors, preferably of platinum combs; sulphuric acid is formed and condensed. 4 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

3,905. "Improvements in suspension devices for electric and other lamps." P. G. Pasquet. Dated February 16th, 1898. A yoke secured to a ceiling or wall has three projections supporting a hollow ball which carries a tube containing another sliding tube supporting an electric or other lamp or gas burner. The ball is held frictionally by a ring and springs of any kind. In modifications, the ring and springs are dispensed with, the yoke being made longer, and the tube extended above the ball to carry a counterweight, or the upper part of the ball made solid to serve as a counterweight. Gas may be supplied to the burner by flexible tubing. Electric current may be supplied by flexible conductors, controlled by a spring coiled on the tube, or a spring roller, or pulleys and weights; segmental rods may slide within corresponding conducting strips, within the tubes, or two parallel tubes may be used. 1 claim.

4,004. "Improvements in switches for altering the speed and direction of revolution of electric motors." W. R. Edwards and S. F. Beever. Dated February 17th, 1898. Relates to switches for altering the speed and direction of revolution of electric motors used for propelling boats or for other purposes, where the current is supplied from storage or other batteries. The arrangement may be such, for instance, as to enable a boat to be driven at full speed or half speed ahead, or at full speed or at half speed astern. For this purpose, the battery is divided into two halves, and the two speeds are obtained by connecting these in series or parallel, as the case may be, while the direction of revolution is changed by reversing the connections of the armature or field magnet. An auxiliary resistance switch is employed for preventing sparking at the contacts of the main switch. The main switch comprises, in addition to a central contact, two series of concentrically-arranged contacts which are cross-connected. Above these contacts is arranged a rotary switch arm carrying six spring brushes, connected together in three sets as shown in dotted lines. A resistance switch is interposed between the main switch and the field terminal of the motor. This comprises two quadrantal series of resistance contacts, an inner contact and a rotary bridge-piece shown in dotted lines. The two switches are geared together in such a manner that one complete revolution of the resistance switch causes the main switch arm to move from one of its five positions to the next. When the latter is in the highest position shown, the two parts of the battery are connected in series for full speed ahead, while in the next position the two parts are connected in parallel for half speed ahead. When it reaches the horizontal position, the current is cut off and the motor stopped. Further movement reverses the armature connections and puts the two halves of the battery first into parallel for half speed astern, and then into series for full speed motors. 4 claims.

4,046. "Improvements in or connected with the distribution of electricity on the three-wire system with the neutral wire at earth potential." A. B. Blackburn, W. L. Spence and E. S. W. Moore. Dated February 17th, 1898. Relates to a system of three-wire distribution for railways and other purposes, in which two or three wire circuit generators are arranged with balancing transformers so that the central point is earthed and the greatest difference between the feeding leads is double that between the lead and earth. The balancing transformers are preferably those of the variable ratio type described in Specifications No. 11,153 and No. 24,296, A.D. 1895, and may be controlled by an electric governor such as described in Specification No. 19,871, A.D. 1896. In a modification a triple commutator transformer may be employed, the whole of the branch network being taken by this one transformer. 3 claims.

4,075. "Improvements in methods and apparatus for electro-thermally treating materials, more particularly for the manufacture of calcium carbide and other carbides, and the reduction of ores." H. Maxim. Dated February 18th, 1898. A furnace for making calcium carbide, reducing ores, or other purposes, is provided with two or more parallel electrodes, which are covered with the materials. On starting they are connected by an incandescent conductor, and during an operation they are gradually withdrawn lengthways from the furnace, leaving a layer or layers of the product, which is removed as slabs after cooling, or in the fused state. The furnace may be movable on wheels, and the electrodes stationary. Adjacent pairs of electrodes may be supplied with separate currents, or multiphase alternating currents may be used. The starting conductor may be a carbon plate, grooved so as to be readily broken, or a line of broken carbon. The electrodes may be solid and be passed into the furnace through carbon tubes, electric connection being maintained by carbon powder; or hollow electrodes may be used, and coal dust fed through them. They may be cooled by water pipes. A pair of electrodes may be used to close a hole for discharging the product, which is kept fused near the hole by these electrodes. Several furnaces may be movable in an outer casing. The gaseous products of the furnaces, or other fuel, may be burnt with an air blast to heat the fresh materials, the air being heated by the products of combustion, or by burning some gas in it. The supply of material is controlled by two valves. 14 claims.

4,282. "Improvements in automatic cut-outs for arc electric lamps." G. Byng and A. E. Angold. Dated February 21st, 1898. Relates to a cut-out for the shunt coil of an arc lamp for protecting it from the full electromotive force of the circuit. A lever pivoted to the frame, and carrying a contact head, normally rests against a contact and closes a circuit through the shunt coil. A weight loosely mounted tends to hold the lever in position. It is fitted with a pin which projects into the path of an arm mounted on a spindle forming part of the regulating mechanism. The lever also carries a pin or tooth with which engages a pawl pivoted on the arm and having a small independent movement controlled by a pin working in a slot. When the carbons are burnt out the arm is thrown over against the contact, so cutting out the shunt coil. 2 claims.

4,306. "Improvements in electrodes for secondary batteries." P. W. Northey. Dated February 21st, 1898. The plate or grid is made up of a series of independent sections of short ribs supported at their ends by cross-bars. The ribs may be at any angle with the sides of the grid, and those in some sections may be at a different angle to those in other sections. A diagonal bar aids in the collection of the current. 3 claims.

4,441. "Improvements in or relating to electric motors." H. O. Duncan. Dated February 22nd, 1898. (Date claimed under Patents, &c., Act, 1883, Section 103, January 14th, 1898, being date of application in France.) Relates to electric steering propeller motors for pleasure boats and other vessels. The motor is mounted on four columns so that it may be raised and lowered by means of a screw passing through a frame or base. This frame is secured to two approximately vertical tubes, which terminate below in a water-tight casing in which is arranged the shaft of a screw propeller. These parts are detachably mounted on the stern of the vessel. The pulley on the motor shaft transmits motion to a second pulley on the screw propeller shaft by means of a belt or its equivalent, the tension of which can be varied by operating the screw so as to raise or lower the motor. To the frame is secured a bar terminating in a steering-handle, and covered by a tube through which pass the conducting wires. This handle can also be rotated so as, by a suitable arrangement of contacts, to reverse or stop the motor. A sheet-metal plate, acting as a rudder, is secured to the casing. 2 claims.

5,029. "Improvements in regulating apparatus for arc lamps." H. Leitner. Dated March 1st, 1898. Relates to arc lamps. An electromotor regulating apparatus is constructed as shown. The carbon holders are hung by cords on opposite sides of a horizontal shaft, or otherwise connected to this, and may be weighted so that they tend to move apart. The shaft carries an armature wound with fine wire and provided with a commutator and brushes by which it is connected in series with fine windings on a differently wound field magnet, this circuit being connected between the terminals of the lamp. The other winding of the magnet is in series with the carbons. The magnet is finely laminated, and the two coils on it may be connected together either in series or parallel to adapt the lamp for different currents. 1 claim.

5,064. "Improvements in non-synchronous electric motors." R. Belfield. (E. G. Lamme.) Dated March 1st, 1898. Relates to motors, alternating current. In a rotary field motor the primary member is provided with a distributed drum winding, which, when supplied with polyphase currents, will produce a rotating field closely approximating in effect to a single pole of uniform strength mechanically rotated. For this purpose each coil of the winding is made to embrace a circumferential core space, the width of which is either materially greater or materially less than that obtained by dividing the whole circumference by the number of poles. 2 claims.

5,066. "Improvements in electric switches." R. Belfield. (H. P. Davis). Dated March 1st, 1898. Electric switches. Contact is secured between the movable arm and the fixed contacts by means of curved and slotted metallic washers. In order to give a quick break a supplementary contact pivoted between plates and working between spring contacts may be provided. The head is held between the contacts until the switch arm is raised into the position shown in dotted lines, when the heel forces it out and the springs give a quick break. 2 claims.

5,133. "Improvements in electric lamp fittings." J. M. Haisman and H. C. Cover. Dated March 2nd, 1898. An electric incandescent lampholder is provided with a ring carrying a silvered or enamelled reflector and serving also to support an ordinary shade. A coloured or ornamental glass is supported by engaging its flanged edge with springs on the reflector. 1 claim.

5,172. "Improvements in telephone transmitter." J. V. Collingwood. Dated March 2nd, 1898. A microphone is formed of a carbon block having conical or other perforations in which are placed balls or their equivalent of compressed carbon or other suitable material. The balls rest against a carbon diaphragm and the front is provided with a mouthpiece and gauze protector. The apparatus may be reversed, the carbon diaphragm being behind but having an air space round it. The carbon block in this case is mounted on a pine diaphragm which is fixed in the metal casing by an india-rubber washer. 3 claims.

5,177. "Improvements in dynamo-electric machines." W. B. Sayers and Mayer and Coulson, Limited. Dated March 2nd, 1898. Dynamo-electric machines. Comprises improvements on the invention described in Specification No. 27,209, A.D. 1896, according to which reversing poles are employed, in conjunction with commutator coils, for the purpose of enabling a fixed position of the brushes to be maintained without sparking. In one arrangement the reversing pole-pieces are supported in close proximity to the field magnet poles by a non-magnetic carrier, in such a manner that they can be adjusted relatively to the armature and the field magnet poles. The means for effecting this adjustment consist (1) of a pin and slot connection with the carrier, and (2) of set screws acting on the said carrier. According to another arrangement, the reversing pole-pieces are secured to the field magnet poles, or to extensions thereof, by means of screws, and are provided with distance pieces at one end and adjusting screws at the other. In some cases the air gap between the armature surface and the field magnet face is made to gradually increase in radial width towards the polar edge, which is strengthened by armature reaction, and the reversing pole-piece is arranged comparatively close to the armature. The reversing pole-piece may be made up of iron lamine secured between side and end plates, and it may be attached to the field magnet pole, with one end bearing directly against the said pole. 3 claims.

5,580. "Improvements in microphones." A. H. Skold. Dated March 7th, 1898. Microphones.—Microphones are arranged with the granular carbon divided into cells formed by cross-pieces and rings of felt. The cells are faced on their lower surfaces by a central carbon block and two semi-annular blocks, all insulated from each other and mounted on the ebonite disc. The diaphragm has three pieces of tinfoil insulatingly mounted on its under surface and so arranged that the battery current has to pass through all five cells in series. 2 claims.

6,371. "Improvements relating to the driving of sewing machines by electricity." H. Lea. Dated March 15th, 1898. Relates to means whereby an electric motor can be readily applied to any existing sewing machine and its action controlled by a pedal switch. The motor is secured to a wooden base by means of screws passing through a slotted plate, so that its position relatively to the machine may be adjusted for the purpose of tightening the driving cord. Upon the motor spindle is a brake wheel, to which a brake shoe is applied by a lever acted on a spring. When the motor is started by depressing the pedal switch an electro-magnet connected in series with it attracts one end of the lever, and releases the brake; when, however, the motor circuit is broken, the brake is again applied by the action of the spring. The electric driving apparatus is attached to the machine by means of metallic tongues on the base of one fitting into mortices or sockets on the base of the other. 1 claim.

"Electrical Review" List of Electri

OVERHEA

LOCALITY.	Lines owned by.	Track.	Gauge.	Weight of Rails per yard.	Character of Overhead Work.	Number of		Car Motors.	POWER STATIO	
						Motor Cars.	Trailers		Boilers.	Engines.
Aberdeen	Corporation	2¼ miles double, ¼ mile single	ft. in. 4 8½	98 lbs.	1¼ miles centre pole, 1¼ miles span wire	8	—	Westinghouse, 30 h.p., two per car	8 Babcock-Wilcox	Willans and Bel
Blackburn	Corporation	4 miles	4 0	92½ lbs.	Bracket arms, with centre and side poles	8	—	Siemens, two per car	*	*
Blackpool	Corporation	Running and arranged for, 11½ miles single	4 8½	96 lbs.	Bracket arms, with side and centre poles	16	—	G.E. 52	—	Parsons steam tu
Blackpool and Fleetwood	Blackpool and Fleetwood Tramroad Co., Ltd.	6½ miles of enclosed road for high speed, 2 miles tramway	4 8½	98 lbs., 83 lbs., and 56 lbs.	Bracket arm, centre and side poles, span wire	24	3	G.E. 1000 (bogie)	4 Lanc., 30 ft. by 8 ft., and economiser	5 Mather-Platt coupled marine pound, 200 h.p revolutions per m
Bolton	Corporation	31 miles single (14 miles new)	4 8½	100 lbs.	Mainly side brackets, span wire	70	30 or 40	2 30 h.p. Walker per car	—	Vertical compoun liss
Bradford	Corporation	5 miles girder and Demerbe	4 0	109 lbs.	Bracket arm suspension	24	4	Westinghouse, No. 49	10, of 4,420 h.p.	13, of 4,530 h.p.
Brighton and Rottingdean	Brighton and Rottingdean Seashore Electric Tramroad Co.	3 miles, 2 tracks used as one, 18 ft. over all	Each track 2 8½	55 lbs.	Steel and wood poles, bridle suspension	1	—	4 G.E.	—	—
Bristol	Bristol Tramways and Carriage Co.	8½ miles	4 8½	92½ lbs.	Side and centre poles, and span wire	51	15	G.E. 800	4 Lanc.	4 250 h.p., McI Seymour, direct 200 revs.
Carlisle	City of Carlisle Electric Tramways Co., Ltd.	7½ miles	3 6	86 lbs.	—	12	—	2 20 h.p. per car	—	—
Cork	Cork Tramways and Electric Ltg. Co., Ltd.	5 miles double, 2 miles single	3 0	86 lbs.	Chiefly centre pole, with bracket arms	28	—	B.T.H.	6 Babcock-Wilcox	3 McIntosh-Seymo Allis, horiz. ta compound
Coventry	Coventry Electric Tramways Co.	5½ miles single	3 6	84 lbs.	Cross suspension and side brackets	20	5	Each car 2 20 h.p., Westinghouse	2 172 h.p., water tube	2 150 h.p., Browett- ley comp. conc rect coup.; 250
Do.	Do.	5 miles single rail joints Falk cast weld process, steel sleepers	—	65 lbs.	—	—	—	—	2 106 h.p., water tube	2 150 h.p., do., bel
Darwen	Corporation	2·84 miles, double track	4 0	95 lbs.	Span wire rosettes and side poles	10 (bogie)	—	G.E. 52, W. 49, W. 46	3 Lanc., 30 ft. by 8 ft., refuse destructor	Belliss-Morcom, 2 b.h.p., 1 450 b.h.
Devonport and Suburbs	Devonport and District Tramways Co.	4½ miles double, ⅛ mile single	3 6	92½ lbs.	Side trolley throughout	—	—	—	—	—
	Devonport Corporation	¾ mile double	3 6	—	Not decided	—	—	—	—	—
Dover	Corporation	3 miles single, 1½ miles double	3 6	87 lbs.	Side poles with bracket arms	16	—	G.E. 800	2 water tube	2 horiz. tandem pound
Dublin and District	Dublin United Tramways Company, Ltd.	Double principally, 39 miles track	5 3	92 lbs.	Centre pole, span wire, and side poles	200	30	G.E. 52 and 800	12 Babcock-Wilcox	6 Allis, 600 h.p. eac
Dublin and Lucan	Dublin and Lucan Steam Tramways Co.	6¼ miles single, ½ mile double	3 6	—	—	—	—	—	—	2 compound horiz condensing
Dudley, Stourbridge, and District	Dudley, Stourbridge, and District Electric Traction Co.	5½ miles	3 6	90 lbs.	Span wire, centre pole, side brackets	18	—	G.E. 800	3 Lanc., 28 ft. by 7 ft.	3 175 i.h.p. Ball- horizontal ta compound
Dundee	Corporation	3½ miles double track	4 8½	90 lbs. and 94 lbs.	Side and centre poles, with bracket arm and side trolley	20	—	Electrical Equipment Co.	Lanc., 4 30 ft. by 8 ft., 4 24 ft. by 7 ft.	Willans
East Ham	District Council	1½ miles double, 2½ miles single	4 8½	87 lbs.	Side poles, with bracket arms	10	—	—	4 water tube	4 compound horiz direct coupled
Giant's Causeway, Portrush, and Bush Valley	Giants' Causeway, Portrush, and Bush Valley Railway and Tramway Company	8½ miles single	3 0	—	Overhead trolley	5	—	Siemens, 1 per car, chain gear	—	2 turbines, 50 h.p.
Glasgow	Corporation	Running, 3¼ miles double Ready, 1¾ mile double	4 7¾	100 lbs.	Span wire	36	—	General Electric and Westinghouse	2 Babcock-Wilcox	3 McIntosh - Sey tandem compoun revs. per minute
Guernsey	Guernsey Railway Company	3 miles single	4 8½	40, 74, and 82 lbs.	—	8	7	Siemens, and G.E. 800	2 loco., 1 Babcock-Wilcox	2 compound
Halifax	Corporation	11¼ miles	3 6	98 lbs.	Side poles	40	—	E.C.C., Westinghouse, B. T. H.	Lanc. and water tube	Low speed horiz. high speed, Bellis
Hartlepool	General Electric Tramways Co., Ltd.	4½ miles single	3 6	65 lbs.	Side trolley (Dickinson)	15	—	E.C.C. 1 per car, and others	2 Galloway, 20 ft. by 6 ft., 1 Tinker	3 Willans vertical pound
Hull	Corporation	9 miles double, 1 mile single, centre groove rails	4 8½	96 lbs.	Bracket arm, with centre poles, side poles, and span wire	60	20	Westinghouse and Siemens	4 Lanc., 30 ft. by 8 ft.	3 Belliss tandem pound
Isle of Man—(1) DOUGLAS AND LAXEY	Isle of Man Tramways and Electric Power Co.	(1) 14 miles single	3 0	56 lbs.	Bracket arm, centre pole	13	14	2 20 h.p. per car	5 Lanc., 20 ft. by 6 ft.	5 Mather-Platt ve comp., 90 h.p. ea
(2) LAXEY AND RAMSEY		(2) 21 miles single	3 0	62½ lbs.	Do.	9	9	4 20 h.p. per car	3 Galloway, 26 ft. by 6 ft. 6 ins.	3 Mather-Platt h tandem comp., h.p. each
(3) SNAEFELL MOUNTAIN		(3) 11 miles single	3 6	56 lbs. 65 lbs.	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Mather-Platt h comp., 120 h.p. e
Kidderminster and Stourport	Kidderminster and Stourport Electric Tramways Co.	4½ miles	3 6	75 lbs.	Bracket arms	9	4	Double motor equipments	3 Babcock-Wilcox	3 Universal, 150 h each
Leeds	Corporation	Running 7 miles double	4 8½	100 lbs.	Bracket arm, centre and side poles	75	18	G.E. 600 and G.E. 58	6 Lanc., 30 ft. by 8 ft.	Fowler horizontal pound condensin 400 h.p., 1 1,300
Liverpool	Corporation	20·6 miles	4 8½	98 lbs.	Span wires and bracket arms with centre poles	86	15	Schückert, Walker, G.E. 52 and 58, Westinghouse Brush	Lanc., 30 ft. by 8 ft.	Willans, 300 and h.p.
‡ London ACTON, SHEPHERD'S BUSH, KEW, AND HOUNSLOW	London United Tramways Co., Ltd.	20 miles	4 8½	—	Double trolley, four overhead wires, three-wire system	—	—	—	8 water tube, weighing hoppers, mechanical stokers	4 750 h.p. cross pound condensing revs., 2 crank tar compound
Manchester	Corporation	—	—	—	Span wires (probably)	—	—	—	—	—
Middlesbrough, Stockton, and Thornaby	Imperial Tramways Co., Ltd.	15 miles	3 6	92½ lbs.	Centre and side poles, bracket arm	8 wheel bogie cars	—	G.E. 800	3 water tube, weighing hopper	3 400 h.p. Reyn Corliss horiz cross compound densing engines (
Norwich	Norwich Electric Tramways Co.	13 miles single 3 miles double	3 6	65 lbs.	Bracket arm and span wire, with side poles and rosettes	40	—	Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.	4 300 h.p. Bro Lindley comp tandem condensi
Nottingham	Corporation	14½ miles double, 4 miles single	4 8½	100 lbs.	—	—	—	—	—	—
Oldham	Corporation	25 miles	4 8½	100 lbs.	—	—	—	—	—	—
Oldham, Ashton, and Hyde	Oldham, Ashton, and Hyde Electric Tram. Co.	8 miles	4 8½	90 lbs.	Span wire	26	12 (on order)	Double motor equipments, G.E. 50	—	—
Plymouth	Corporation	3·1 miles single working, 2·7 miles to be equipped	3 6	92 lbs.	Side brackets and span wires	6	6	Westinghouse, 2 25 h.p.	3 Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h.p., revs.
Potteries (North Staffordshire)	Potteries Electric Trac. Co., Ltd.	33 miles	4 0	87½ lbs.	Span wire	20	20	G.E. 800	3 Lancs, 30 ft. by 7 ft., economiser	2 McIntosh-Seym 330 h.p. horiz. dem comp.
St. Helen, Lancashire	Corporation	6 miles running, 13 miles constructing	4 8½	—	Span wire and side brackets, centre	—	—	G.E. 52	2 Lancashire, 2 Bab-	4 Willans, 2 360

ectric Tramways and Railways in the Unite

HEAD TROLLEY LINES.

POWER STATION EQUIPMENT.				CAPITAL OUTLAY.									
	Engines.	Generators.	Total capacity in KW.	Permanent Way.	Power Station.	Rolling Stock and Electrical Equipments.	Total.	Date opened.	Tramways Manager.	Electrical Engineer.	Annual Car Mileage.	Cost per Car Mile, Pence.	Ratio of Expenses to Rec eipts.	REMA
...	Willans and Belliss ..	Bruce-Peebles, 200 kw.; Mather-Platt, 390 kw; Holmes, 110 kw.	700	—	—	—	£32,000	—	D. Moonie..	J. Bell	—	—	—	Line to be finished by the middle extension sanctioned.
	*	*	*	—	*	£16,918	—	March, 1899	A. S. Giles ..	A. S. Giles..	153,390	6·86	44 %	Corporation now equipping 15 mil motor cars, each with 4 motors, * Combined lighting and tractio
	Parsons steam turbines	Parsons	250	—	—	Cost of conversion estimated at £10,000	—	June, 1899	J. Lancaster	R. C. Quin..	Last year (conduit system), 259,754	—	—	Combined lighting and traction st trolley system five months ago, fo to extend track 15 miles.
ft.,	5 Mather-Platt direct coupled marine compound, 200 h.p., 165 revolutions per minute	Mather-Platt, multipolar shunt, 120 kw., chloride battery, 360 kw. hr.	600	£96,522	£54,771 *	£17,365	£168,658	July, 1898	J. Cameron (and Sec.)	J. W. Mahon	355,565	8	49·7 %	* Including overhead wires, poles
	Vertical compound Corliss	2 1,000 i.h.p., 2 500 i.h.p., 12-pole Mather-Platt	Ltg. and traction station, 3,000 i.h.p.	New track, £70,000; value of old, £50,000	£40,000 (about)	£85,325 *	—	Jan. 1st, 1900 (appr'x.)	A. Ellis	A. Ellis	—	—	—	Combined lighting and traction sta * Includes cars, £34,825; overhe £6,500; feeders, £18,000. Lease, £50,000.
..	13, of 4,530 h.p.....	13	2,769	£49,490	—	£32,854	—	July, 1898	C. J. Spencer	A. H. Gibbings	344,519	—	—	2 lines running, 3 lines constructi yet sanctioned. Combined light
	——	——	60	—	—	—	£35,792	Nov., 1896	M. Volk	M. Volk	—	—	70·3 %	60 kw. direct current G.E. tran Tudor battery.
..	4 250 h.p., McIntosh-Seymour, direct coup., 200 revs.	4 B.T.H., 150 kw. neg. boosters	600	—	—	—	—	Oct., 1895	Geo. White (Managing Director)	J. C. Robinson, H. F. Parshall (consg.)	—	—	—	50 miles, changing to electricity. 2 station now erecting (10-pole direc
	——	——	—	—	—	—	—	—	—	—	—	—	—	Current supplied by Corporation. L neers, Pritchard & Co., A. Dick early in 1900.
..	3 McIntosh-Seymour, 2 Allis, horiz. tandem compound	B.T.H.	1,400 *	—	*	—	—	Dec., 1898	W. G. Davis	C. H. Merz (and Sec.)	About 700,000, estimated	—	—	* Combined lighting and traction st
..	2150 h.p., Browett-Lindley comp. cond. direct coup.; 250 revs.	4 100 kw. Westinghouse, 1 17 kw.	417	—	—	—	£126,000	Dec., 1895	T. R. Whitehead	J. E. Winslow	—	—	—	——
..	2 150 h.p., do., belted ..	——	—	—	—	—	—	July, 1899	—	—	—	—	—	——
t.,	Belliss-Morcom, 2 250 b.h.p., 1 450 b.h.p. ..	Siemens, 2 150 kw. comp. 1 300 kw. shunt	600	£15,000 (doubling present line)	—	£15,000	£56,500 *	—	—	R. W. Smith-Saville and S. Clegg	—	—	—	* Inclusive of £26,500 for tramway power station.
	——	——	—	—	—	—	—	—	—	F. S. Pilling, Res. Eng.	—	—	—	Power from Devonport Corporation E well, C. H. Gadsby, Joint Engine
	——	——	—	—	—	—	—	—	—	—	—	—	—	C. Chadwell, Engineer. Powers obt begun.
..	2 horiz. tandem compound	2 G.E., 6-pole compound	200	£16,944, including bonding	Owned by a Company	£13,311	£30,255	Sept., 1897	E. Carden ..	E. Stilgoe ..	204,257, 1899.	5·68	52 %	——
..	6 Allis, 600 h.p. each ..	6 B.T.H., 500 kw.	3,000	—	—	—	—	—	C. W. Gordon	Consulting: H. F. Parshall, Resident: J. W. Towle	—	—	—	There are two other stations at prese but they will be closed down as s Ringsend is completed.
	2 compound horizontal condensing	Two.....	—	—	—	—	—	—	M. Rathborne	W. F. Clarke	—	—	—	Now converting from steam to electric
..	3 175 i.h.p. Ball-Wood horizontal tandem compound	3 100 kw. Thomson-Houston	300	—	—	—	—	July, 1899	R. Smith ..	R. N. Tweedy	287,000 (estimated)	—	—	Line within Borough of Dudley supplie stn. Now constructing: Dudley a per yard; Kinver, 4½ miles, 90 lbs span wire and side brackets.
.,	Willans	Parker and Siemens ..	1,760	£31,241	£41,810 *	£16,980 †	£91,791 †	—	P. Fisher ..	W. H. Tittensor	—	—	—	Lines in process of conversion ..... * Power to be supplied from lighting s † Exclusive of cables.
.	4 compound horizontal direct coupled	4 direct current	825	—	—	—	—	—	W. C. Ullmann	W. C. Ullmann	—	—	—	Lines not yet constructed, but contracts
	2 turbines, 50 h.p. each	2 Siemens	—	—	—	—	£46,841	Mar., 1883	—	W. A. Traill	11,333	—	—	Traffic partly worked by steam in addit
.	3 McIntosh-Seymour tandem compound 200 revs. per minute	3 200 kw. each, 8 poles	600 (3½ miles)	£415,976 (40 miles)	£21,193 (3½ miles)	£45,446	£482,615	Oct., 1898	J. Young....	W. Clark (chf.), A. E. Le Rossignol, (assistant)	760,000 (3½ miles)	5·75	40 %	35 miles double track being electri double track to be constructed.
k-	2 compound	Siemens, compound ..	100	—	—	—	£33,628	Feb., 1892	A. L. Davis	A. L. Davis	142,116	—	—	——
	Low speed horiz. and high speed, Belliss	E. C. C.....	1,250	£40,000	£73,000	£24,000	£137,000	June, 1898	F. Spade ..	H. F. Strect	*	*	*	24 miles new track under construction, * Traffic rapidly increasing, exact fig
.,	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt, E.P.S. battery	120	—	—	—	£33,137	May, '96 and Feb., '99	L. S. Gallaworthy	—	135,740	8·08	71·25 %	Lines worked and extensions (2½ mil Electric Tramways Co., Ltd.
.	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (station), £6,883 (depots),	£17,700	£87,244 *	July, 1899	W. J. McCombe	A. S. Barnard	—	—	—	3½ miles double track now running..... * Capital outlay figures are to Septembe
.	5 Mather-Platt vertical comp., 90 h.p. each	5 Mather-Platt, 50 kw. each	250	—	—	—	—	July, 1894	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station .....
y	3 Mather-Platt horiz. tandem comp., 180 h.p. each	3 Mather-Platt, 120 kw. each	360	—	—	—	—	Aug., 1898	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....
t.	5 Mather-Platt horiz. comp., 120 h.p. each	5 Mather-Platt, 60 kw. each	300	—	—	—	—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....
.	3 Universal, 150 b.h.p. each	6-pole Mordey direct coupled, 100 kw. each	300	—	—	—	—	May, 1898	A. Stewart (Suprtdt.)	J. B. Clarke (Power Suprtdt.)	146,000 (estimated)	—	—	——
.	Fowler horizontal compound condensing, 2 400 h.p., 1 1,300 h.p.	4 2-pole, 125 kw. each; 1 12-pole, 750 kw.	1,250	—	—	—	—	Aug., 1897	W. Wharam	J. Burbidge	30,000 miles per car	4·83	39 %	22 miles track in construction, 36 miles
.	Willans, 800 and 1,200 h.p.	Siemens	1,200	£67,469	—	£58,492	£125,961	Nov., 1898	C. R. Bellamy	A. B. Holmes	Present daily mileage about 5,000	—	—	Energy purchased from Electric Lighti entire city lines are reconstructing fo the rate of about 1 mile per week.
g l	4 750 h.p. cross compound condensing, 90 revs., 2 crank tandem compound	2 cont. cur.; 1 direct coupled, 500 kw., 3-phase 5,000 volts, 2 75 kw. 500 volts for ltg.; 200 kw. rotary convt. and static trans. at sub-station	(Station capacity to be 5,000 h.p.)	—	—	—	—	—	J. C. Robinson, Engineer	H. F. Parshall, Consulting Engineer	—	—	—	About 1 mile of conduit, ¾ in. slot, centr road, 75 miles track, total length of li moting, &c.).
	——	——	—	—	—	—	£860,000 voted	—	—	C. H. Wordingham	—	—	—	Power from lighting station .....
g	3 400 h.p. Reynolds-Corliss horizontal cross compound condensing engines (Allis)	3 300 kw., 32-pole, 2,500 volt, 3-phase alter., 2 4-pole, 200 kw., rotary conv. and trans. at sub-station	—	—	—	—	—	Aug., 1898	J. C. Robinson, Director and Engineer	—	—	—	—	——
0	4 300 h.p. Browett-Lindley compound tandem condensing	4 Westinghouse direct coupled, 200 kw.	800	—	—	—	—	—	A. N. Banister	A. N. Banister	—	—	—	Lines constructing .....
	——	——	—	—	—	—	—	—	J. Aldworth	H. Talbot ..	—	—	—	Arrangements now proceeding for equipment
	——	——	—	—	—	—	—	—	—	—	—	—	—	Drawings and specifications now preparin hands of the Borough Surveyor, Mr. S. A.
	——	——	—	—	—	—	—	June, 1899	E. H. Mottram (Suprtdt.)	J. A. Fraser (Power (Suprtdt.)	—	—	—	Current obtained from the Ashton-under-Lyn
	2 Belliss, 150 h.p., 375 revs.	2 Westinghouse, 6-pole, 100 kw.	200	—	£56,000 *	£7,500	—	Sept., 1899	C. R. Everson	J. H. Rider	Estimated at 150,000	—	—	* Combined lighting and traction plant ....
	2 McIntosh-Seymour, 380 h.p. horiz. tandem comp.	2 G.E., 200 kw., 6 pole, 1 30 kw.	430	—	—	—	—	May, 1899	S. Olver	S. Olver	—	—	—	Capital issued £400,000; electrical equipment miles running.
	4 Willans, 2 360 h.p.	Mather-Platt, 4 ...												

Review" List of Electric Tramways and Ra

OVERHEAD TROLLEY

	Gauge.	Weight of Rails per yard.	Character of Overhead Work.	Number of Motor Cars.	Number of Trailers	Car Motors.	POWER STATION EQUIPMENT. Boilers.	Engines.	Generators.	Total capacity in KW.	CAPITAL OUTLAY. Permanent Way.	Power Station.	Rolling Stock and Electrical Equipments.	Total.	Da oper
...le,	ft. in. 4 8½	98 lbs.	1½ miles centre pole, 1½ miles span wire	8	—	Westinghouse, 30 h.p., two per car	8 Babcock-Wilcox	Willans and Belliss ..	Bruce-Peebles, 200 kw.; Mather-Platt, 390 kw; Holmes, 110 kw.	700	—	—	—	£32,000	—
....	4 0	92½ lbs.	Bracket arms, with centre and side poles	8	—	Siemens, two per car	*	*	*	*	—	*	£16,918	—	Mar 189
...ar- 1½	4 8½	96 lbs.	Bracket arms, with side and centre poles	16	—	G.E. 52	—	Parsons steam turbines	Parsons	250	—	—	Cost of conversion estimated at £10,000	—	Jun 189
...n- ...or 2 ...y	4 8½	98 lbs., 83 lbs., and 56 lbs.	Bracket arm, centre and side poles, span wire	24	3	G.E. 1000 (bogie)	4 Lanc., 30 ft. by 8 ft., and economiser	5 Mather-Platt direct coupled marine compound, 200 h.p., 165 revolutions per minute	Mather-Platt, multipolar shunt, 120 kw., chloride battery, 360 kw. hr.	600	£96,522	£54,771 *	£17,365	£168,658	Jul 189
...14	4 8½	100 lbs.	Mainly side brackets, span wire	70	30 or 40	2 30 h.p. Walker per car	—	Vertical compound Corliss	2 1,000 i.h.p., 2 500 i.h.p., 12-pole Mather-Platt	Ltg. and traction station, 3,000 i.h.p.	New track, £70,000; value of old, £50,000	£40,000 (about)	£85,325 *	—	Jan. 190 (appr
...er	4 0	109 lbs.	Bracket arm suspension	24	4	Westinghouse, No. 49	10, of 4,420 h.p.	13, of 4,530 h.p.....	13	2,769	£49,490	—	£32,854	—	Jul 189
...s	Each track 2 8½	55 lbs.	Steel and wood poles, bridle suspension	1	—	4 G.E.	—	—	—	60	—	—	—	£35,792	No 189
...	4 8½	92½ lbs.	Side and centre poles, and span wire	51	15	G.E. 800	4 Lanc.	4 250 h.p., McIntosh-Seymour, direct coup., 200 revs.	4 B.T.H., 150 kw. neg. boosters	600	—	—	—	—	Oct 189
...	3 6	86 lbs.	—	12	—	2 20 h.p. per car	—	—	—	—	—	—	—	—	—
...	3 0	86 lbs.	Chiefly centre pole, with bracket arms	28	—	B.T.H.	6 Babcock-Wilcox	3 McIntosh-Seymour, 2 Allis, horiz. tandem compound	B.T.H.	1,400 *	—	*	—	—	Dec 189
...	3 6	84 lbs.	Cross suspension and side brackets	20	5	Each car 2 20 h.p., Westinghouse	2 172 h.p., water tube ..	2 150 h.p., Browett-Lindley comp. cond. direct coup.; 250 revs.	4 100 kw. Westinghouse, 1 17 kw.	417	—	—	—	£126,000	Dec 189
...	—	65 lbs.	—	—	—	—	2 106 h.p., water tube ..	2 150 h.p., do., belted ..	—	—	—	—	—	—	July 189
...	4 0	95 lbs.	Span wire rosettes and side poles	10 (bogie)	—	G.E. 52, W. 49, W. 46	3 Lanc., 30 ft. by 8 ft., refuse destructor	Belliss-Morcom, 2 250 b.h.p., 1 450 b.h.p. ..	Siemens, 2 150 kw. comp. 1 300 kw. shunt	600	£15,000 (doubling present line)	—	£15,000	£56,500 *	—
...	3 6	92½ lbs.	Side trolley throughout	—	—	—	—	—	—	—	—	—	—	—	—
...	3 6	—	Not decided	—	—	—	—	—	—	—	—	—	—	—	—
...	3 6	87 lbs.	Side poles with bracket arms	16	—	G.E. 800	2 water tube	2 horiz. tandem compound	2 G.E., 6-pole compound	200	£16,944, including bonding	Owned by a Company	£13,311	£30,255	Sept 189
...	5 3	92 lbs.	Centre pole, span wire, and side poles	200	30	G.E. 52 and 800	12 Babcock-Wilcox	6 Allis, 600 h.p. each ..	6 B.T.H., 500 kw.	3,000	—	—	—	—	—
...	3 6	—	—	—	—	—	—	2 compound horizontal condensing	Two.....	—	—	—	—	—	—
...	3 6	90 lbs.	Span wire, centre pole, side brackets	18	—	G.E. 800.....	3 Lanc., 28 ft. by 7 ft...	3 175 i.h.p. Ball-Wood horizontal tandem compound	3 100 kw. Thomson-Houston	300	—	—	—	—	July 189
...	4 8½	90 lbs. and 94 lbs.	Side and centre poles, with bracket arm and side trolley	20	—	Electrical Equipment Co.	Lanc., 4 30 ft. by 8 ft., 4 24 ft. by 7 ft.	Willans	Parker and Siemens ..	1,760	£31,241	£41,810 *	£16,980 †	£91,791 †	—
...	4 8½	87 lbs.	Side poles, with bracket arms	10	—	—	4 water tube	4 compound horizontal direct coupled	4 direct current	825	—	—	—	—	—
...	3 0	—	Overhead trolley ..	5	—	Siemens, 1 per car, chain gear	—	2 turbines, 50 h.p. each	2 Siemens	—	—	—	—	£46,841	Mar. 188
...	4 7¾	100 lbs.	Span wire	36	—	General Electric and Westinghouse	2 Babcock-Wilcox	3 McIntosh-Seymour tandem compound 200 revs. per minute	3 200 kw. each, 8 poles	600 (3½ miles)	£415,976 (40 miles)	£21,193 (3½ miles)	£45,446	£482,615	Oct. 189
...	4 8½	40, 74, and 82 lbs.	—	8	7	Siemens, and G.E. 800	2 loco., 1 Babcock-Wilcox	2 compound	Siemens, compound ..	100	—	—	—	£33,628	Feb. 189
...	3 6	98 lbs.	Side poles	40	—	E.C.C., Westinghouse, B. T. H.	Lanc. and water tube	Low speed horiz. and high speed, Belliss	E. C. C.....	1,250	£40,000	£73,000	£24,000	£137,000	June 189
...	3 6	65 lbs.	Side trolley (Dickinson)	15	—	E.C.C. 1 per car, and others	2 Galloway, 20 ft. by 6 ft., 1 Tinker	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt, E.P.S. battery	120	—	—	—	£33,137	May, and Feb.,
...	4 8½	96 lbs.	Bracket arm, with centre poles, side poles, and span wire	60	20	Westinghouse and Siemens	4 Lanc., 30 ft. by 8 ft. ..	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (station), £6,883 (depots),	£17,700	£87,244 *	July 189
...	3 0	56 lbs.	Bracket arm, centre pole	13	14	2 20 h.p. per car	5 Lanc., 20 ft. by 6 ft...	5 Mather-Platt vertical comp., 90 h.p. each	5 Mather-Platt, 50 kw. each	250	—	—	—	—	July 189
...	3 0	62½ lbs.	Do.	9	9	4 20 h.p. per car	3 Galloway, 26 ft. by 6 ft. 6 ins.	3 Mather-Platt horiz. tandem comp., 180 h.p. each	3 Mather-Platt, 120 kw. each	360	—	—	—	—	Aug 189
...	3 6	56 lbs. 65 lbs.	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Mather-Platt horiz. comp., 120 h.p. each	5 Mather-Platt, 60 kw. each	300	—	—	—	—	Aug 189
...	3 6	75 lbs.	Bracket arms	9	4	Double motor equipments	3 Babcock-Wilcox	3 Universal, 150 b.h.p. each	6-pole Mordey direct coupled, 100 kw. each	300	—	—	—	—	May 189
...	4 8½	100 lbs.	Bracket arm, centre and side poles	75	18	G.E. 800 and G.E. 58	6 Lanc., 30 ft. by 8 ft...	Fowler horizontal compound condensing, 2 400 h.p., 1 1,300 h.p.	4 2-pole, 125 kw. each; 1 12-pole, 750 kw.	1,250	—	—	—	—	Aug 189
...	4 8½	98 lbs.	Span wires and bracket arms with centre poles	86	15	Schückert, Walker, G.E. 52 and 58, Westinghouse Brush	Lanc., 30 ft. by 8 ft. ..	Willans, 300 and 1,200 h.p.	Siemens	1,200	£67,469	—	£58,492	£125,961	Nov 189
...	4 8½	—	Double trolley, four overhead wires, three-wire system	—	—	—	8 water tube, weighing hoppers, mechanical stokers	4 750 h.p. cross compound condensing, 90 revs., 2 crank tandem compound	2 cont. cur.: 1 direct coupled, 500 kw., 3-phase 5,000 volts, 2 75 kw. 500 volts for ltg.; 200 kw. rotary convt. and static trans. at sub-station	(Station capacity to be 5,000 h.p.)	—	—	—	—	—
...	—	—	Span wires (probably)	—	—	—	—	—	—	—	—	—	—	£860,000 voted	—
...	3 6	92½ lbs.	Centre and side poles, bracket arm	8 wheel bogie cars	—	G.E. 800	3 water tube, weighing hopper	3 400 h.p. Reynolds-Corliss horizontal cross compound condensing engines (Allis)	3 300 kw., 32-pole, 2,500 volt, 3-phase alter., 2 4-pole, 200 kw., rotary conv. and trans. at sub-station	—	—	—	—	—	Aug 189
...	3 6	65 lbs.	Bracket arm and span wire, with side poles and rosettes	40	—	Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.	4 300 h.p. Browett-Lindley compound tandem condensing	4 Westinghouse direct coupled, 200 kw.	800	—	—	—	—	—
...	4 8½	100 lbs.	—	—	—	—	—	—	—	—	—	—	—	—	—
...	4 8½	100 lbs.	—	—	—	—	—	—	—	—	—	—	—	—	—
...	4 8½	90 lbs.	Span wire	26	12 (on order)	Double motor equipments, G.E. 50	—	—	—	—	—	—	—	—	June 189
...	3 6	92 lbs.	Side brackets and span wires	6	6	Westinghouse, 2 25 h.p.	3 Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h.p., 375 revs.	2 Westinghouse, 6-pole, 100 kw.	200	—	£56,000 *	£7,500	—	Sept 189
...	4 0	87½ lbs.	Span wire	20	20	G E. 800	3 Lancs, 30 ft. by 7 ft., economiser	2 McIntosh-Seymour, 330 h.p. horiz. tandem comp.	2 G.E., 200 kw., 6 pole, 1 30 kw.	430	—	—	—	—	May 189
...	4 8½	—	Span wire and side brackets, centre trolley	—	—	G.E. 52	2 Lancashire, 2 Babcock-Wilcox (destructor), superheaters and economisers	4 Willans, 2 360 h.p. each, 2 200 h.p. each	Mather-Platt, 4-pole; 2 chloride batteries	660	—	£24,000 *	—	—	July 189

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d Railways in the United Kingdom.

EY LINES.

...tock ...rical ...nts.	Total.	Date opened.	Tramways Manager.	Electrical Engineer.	Annual Car Mileage.	Cost per Car Mile, Pence.	Ratio of Expenses to Receipts.	REMARKS.	LOCALITY
	£32,000	—	D. Moonie..	J. Bell	—	—	—	Line to be finished by the middle of December, 1899. £150,000 extension sanctioned.	**Aberdeen**
8	—	March, 1899	A. S. Giles..	A. S. Giles..	153,390	6·86	44 %	Corporation now equipping 15 miles of existing track. 60 bogie motor cars, each with 4 motors, and to carry 60 pass., on order. * Combined lighting and traction station.	**Blackburn**
con- n ted 000	—	June, 1899	J. Lancaster	R. C. Quin..	Last year (conduit system), 259,754	—	—	Combined lighting and traction station. Converted to overhead trolley system five months ago, formerly conduit system. About to extend track 15 miles.	**Blackpool**
5	£168,658	July, 1898	J. Cameron (and Sec.)	J. W. Mahon	355,565	8	49·7 %	* Including overhead wires, poles, cables, and buildings.....	**Blackpool and Fleetwood**
5	—	Jan. 1st, 1900 (appr'x.)	A. Ellis	A. Ellis	—	—	—	Combined lighting and traction station ..... * Includes cars, £34,825; overhead work, £26,000; bonding, £6,500; feeders, £18,000. Lease, £55,000; car shed and offices, £50,000.	**Bolton**
4	—	July, 1898	C. J. Spencer	A. H. Gibbings	344,519	—	—	2 lines running, 3 lines constructing, several lines projected not yet sanctioned. Combined lighting and traction station.	**Bradford**
	£35,792	Nov., 1896	M. Volk	M. Volk	—	—	70·3 %	60 kw. direct current G.E. transformer taking town supply, Tudor battery.	**Brighton and Rottingdean**
—	Oct., 1895	Geo. White (Managing Director)	J. C. Robinson, H. F. Parshall (consg.)	—	—	—	—	50 miles, changing to electricity. 250 cars. New central power station now erecting (10-pole direct current generators).	**Bristol**
—	—	—	—	—	—	—	—	Current supplied by Corporation. Lines now constructing. Engineers, Pritchard & Co., A. Dickinson & Co. To be opened early in 1900.	**Carlisle**
—	Dec., 1898	W. G. Davis	C. H. Merz (and Sec.)	About 700,000, estimated	—	—	—	* Combined lighting and traction station.....	**Cork**
£126,000	Dec., 1895	T. R. Whitehead	J. E. Winslow	—	—	—	—	—	**Coventry**
—	July, 1899	—	—	—	—	—	—	—	**Do.**
£56,500 *	—	—	R. W. Smith-Saville and S. Clegg	—	—	—	—	* Inclusive of £26,500 for tramway purchase, but exclusive of power station.	**Darwen**
—	—	—	F. S. Pilling, Res. Eng.	—	—	—	—	Power from Devonport Corporation Electricity Works. C. Chadwell, C. H. Gadsby, Joint Engineers.	**Devonport and Suburbs**
—	—	—	—	—	—	—	—	C. Chadwell, Engineer. Powers obtained, construction not yet begun.	
£30,255	Sept., 1897	E. Carden ..	E. Stilgoe ..	204,257, 1899.	5·68	52 %	—	—	**Dover**
—	—	C. W. Gordon	Consulting: H. F. Parshall, Resident: J. W. Towle	—	—	—	—	There are two other stations at present doing part of the work, but they will be closed down as soon as the new station at Ringsend is completed.	**Dublin and District**
—	—	M. Rathborne	W. F. Clarke	—	—	—	—	Now converting from steam to electricity	**Dublin and Lucan**
—	July, 1899	R. Smith ..	R. N. Tweedy	287,000 (estimated)	—	—	—	Line within Borough of Dudley supplied with power from Corpn. stn. Now constructing: Dudley and district 8¼ miles, 90 lbs. per yard; Kinver, 4½ miles, 90 lbs. per yard; both lines with span wire and side brackets.	**Dudley, Stourbridge, and District**
£91,791 †	—	P. Fisher ..	W. H. Tittensor	—	—	—	—	Lines in process of conversion ..... * Power to be supplied from lighting station. † Exclusive of cables.	**Dundee**
—	—	W. C. Ullmann	W. C. Ullmann	—	—	—	—	Lines not yet constructed, but contracts let.....	**East Ham**
£46,841	Mar., 1883	—	W. A. Traill	11,333	—	—	—	Traffic partly worked by steam in addition	**Giant's Causeway, Portrush and Bush Valley**
£482,615	Oct., 1898	J. Young....	W. Clark (chf.), A. E. Le Rossignol, (assistant)	760,000 (3¼ miles)	5·75	40 %	—	35 miles double track being electrically equipped, 19 miles double track to be constructed.	**Glasgow**
£33,628	Feb., 1892	A. L. Davis	A. L. Davis	142,116	—	—	—	—	**Guernsey**
£137,000	June, 1898	F. Spade ..	H. F. Strect	*	*	*	—	24 miles new track under construction, 1,500 kw. plant on order. * Traffic rapidly increasing, exact figures cannot be given.	**Halifax**
£33,137	May, '96 and Feb., '99	L. S. Gallaworthy	—	135,740	8·08	71·25 %	—	Lines worked and extensions (2½ miles) owned by Hartlepool Electric Tramways Co., Ltd.	**Hartlepool**
£87,244 *	July, 1899	W. J. McCombe	A. S. Barnard	—	—	—	—	3½ miles double track now running..... * Capital outlay figures are to September 30th, 1899.	**Hull**
—	July, 1894	J. Shaw	J. Shaw	—	—	—	—	1 accumulator sub-station	**Isle of Man**—(1) Douglas and Laxey
—	Aug., 1898	J. Shaw	J. Shaw	—	—	—	—	1 accumulator sub-station.....	(2) Laxey and Ramsey
—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	—	1 accumulator sub-station.....	(3) Snaefell Mountain
—	May, 1898	A. Stewart (Suprtdt.)	J. B. Clarke (Power Suprtdt.)	146,000 (estimated)	—	—	—	—	**Kidderminster and Stourport**
—	Aug., 1897	W. Wharam	J. Burbidge	30,000 miles per car	4·83	39 %	—	22 miles track in construction, 36 miles projected	**Leeds**
£125,961	Nov., 1898	C. R. Bellamy	A. B. Holmes	Present daily mileage about 5,000	—	—	—	Energy purchased from Electric Lighting Committee. The entire city lines are reconstructing for electrical working at the rate of about 1 mile per week.	**Liverpool**
—	—	J. C. Robinson, Engineer	H. F. Parshall, Consulting Engineer	—	—	—	—	About 1 mile of conduit, ¾ in. slot, centre of track. (39 miles road, 75 miles track, total length of lines constructing, promoting, &c.).	‡ **London** Acton, Shepherd's Bush, Kew, and Hounslow
£860,000 voted	—	—	C. H. Wordingham	—	—	—	—	Power from lighting station	**Manchester**
—	Aug., 1898	J. C. Robinson, Director and Engineer	—	—	—	—	—	—	**Middlesbrough, Stockton, and Thornaby**
—	—	A. N. Banister	A. N. Banister	—	—	—	—	Lines constructing	**Norwich**
—	—	J. Aldworth	H. Talbot ..	—	—	—	—	Arrangements now proceeding for equipment.....	**Nottingham**
—	—	—	—	—	—	—	—	Drawings and specifications now preparing. Arrangements in hands of the Borough Surveyor, Mr. S. A. Pickering.	**Oldham**
—	June, 1899	E. H. Mottram (Suprtdt.)	J. A. Fraser (Power (Suprtdt.)	—	—	—	—	Current obtained from the Ashton-under-Lyne Corporation	**Oldham, Ashton, and Hyde**
—	Sept., 1899	C. R. Everson	J. H. Rider	Estimated at 150,000	—	—	—	* Combined lighting and traction plant	**Plymouth**
—	May, 1899	S. Olver	S. Olver	—	—	—	—	Capital issued £400,000; electrical equipment £57,418. About 8 miles running.	**Potteries (North Staffordshire)**
—	July, 1899	J. F. Cutler	J. S. Highfield	300,000	—	—	—	Comb. ltg. and traction statn., plant used indifferently for both purposes; plant, track, and overhead equip. owned by the Corporation; New St. Helens and Dist. Tram. Co. work lines and	**St. Helens, Lancashire**

	way Company				and 82 lbs.	—	8	4	Siemens, and G.E. 800	2 loco., 1 Babcock-Wilcox	2 compound ...
Halifax	Corporation	11½ miles	3	6	98 lbs.	Side poles	40	—	E.C.C., Westinghouse, B. T. H.	Lanc. and water tube	Low speed ho high speed, B
Hartlepool	General Electric Tramways Co., Ltd.	4½ miles single ..	3	6	65 lbs.	Side trolley (Dickinson)	15	—	E.C.C. 1 per car, and others	2 Galloway, 20 ft. by 6 ft., 1 Tinker	3 Willans verti pound
Hull	Corporation	9 miles double, 1 mile single, centre groove rails	4	8½	96 lbs.	Bracket arm, with centre poles, side poles, and span wire	60	20	Westinghouse and Siemens	4 Lanc., 30 ft. by 8 ft. ..	3 Belliss tande pound
Isle of Man—(1) DOUGLAS AND LAXEY	Isle of Man Tramways and Electric Power Co.	(1) 14 miles single	3	0	56 lbs.	Bracket arm, centre pole	13	14	2 20 h.p. per car	5 Lanc., 20 ft. by 6 ft...	5 Mather-Platt comp., 90 h.p
(2) LAXEY AND RAMSEY.		(2) 21 miles single	3	0	62½ lbs.	Do.	9	9	4 20 h.p. per car	3 Galloway, 26 ft. by 6 ft. 6 ins.	3 Mather-Platt tandem com h.p. each
(3) SNAEFELL MOUNTAIN		(3) 11 miles single	3	6	56 lbs. 65 lbs.	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Mather-Platt comp., 120 h.
Kidderminster and Stourport	Kidderminster and Stourport Electric Tramways Co.	4½ miles	3	6	75 lbs.	Bracket arms	9	4	Double motor equipments	3 Babcock-Wilcox	3 Universal, 15 each
Leeds	Corporation	Running 7 miles double	4	8½	100 lbs.	Bracket arm, centre and side poles	75	18	G.E. 800 and G.E. 58	6 Lanc., 30 ft. by 8 ft...	Fowler horizon pound conde 400 h.p., 1 1,3
Liverpool	Corporation	20·6 miles	4	8½	98 lbs.	Span wires and bracket arms with centre poles	86	15	Schückert, Walker, G.E. 52 and 58, Westinghouse Brush	Lanc., 30 ft. by 8 ft. ..	Willans, 300 a h.p.
‡ **London** .. .. ACTON, SHEPHERD'S BUSH, KEW, AND HOUNSLOW	London United Tramways Co., Ltd.	20 miles	4	8½	—	Double trolley, four overhead wires, three-wire system	—	—	—	8 water tube, weighing hoppers, mechanical stokers	4 750 h.p. cro pound conde revs., 2 crank compound
Manchester	Corporation	—	—		—	Span wires (probably)	—	—	—	—	—
Middlesbrough, Stockton, and Thornaby	Imperial Tramways Co., Ltd.	15 miles	3	6	92½ lbs.	Centre and side poles, bracket arm	8 wheel bogie cars	—	G.E. 800	3 water tube, weighing hopper	3 400 h.p. R Corliss h cross compou densing engin
Norwich	Norwich Electric Tramways Co.	13 miles single 3 miles double	3	6	65 lbs.	Bracket arm and span wire, with side poles and rosettes	40	—	Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.	4 300 h.p. Lindley co tandem conde
Nottingham	Corporation	14½ miles double, 4 miles single	4	8½	100 lbs.	—	—	—	—	—	—
Oldham	Corporation	25 miles	4	8½	100 lbs.	—	—	—	—	—	—
Oldham, Ashton, and Hyde	Oldham, Ashton, and Hyde Electric Tram. Co.	8 miles	4	8½	90 lbs.	Span wire	26	12 (on order)	Double motor equipments, G.E. 50	—	—
Plymouth	Corporation	3·1 miles single working, 2·7 miles to be equipped	3	6	92 lbs.	Side brackets and span wires	6	6	Westinghouse, 2 25 h.p.	3 Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h revs.
Potteries (North Staffordshire)	Potteries Electric Trac. Co., Ltd.	33 miles	4	0	87½ lbs.	Span wire	20	20	G E. 800	3 Lancs, 30 ft. by 7 ft., economiser	2 McIntosh-S 330 h.p. hor dem comp.
St. Helen, Lancashire	Corporation	6 miles running, 13 miles constructing	4	8½	—	Span wire and side brackets, centre trolley	—	—	G.E. 52	2 Lancashire, 2 Babcock-Wilcox (destructor), superheaters and economisers	4 Willans, 2 3 each, 2 200 h.
Salford	Corporation	40 miles single track	4	8½	106 lbs.	Centre poles where possible (otherwise span wires)	150	—	—	16 Lancashire, 30 ft. 9 ft.	8 compound 100 r.p.m., 1, each
Sheffield	Corporation	2 miles single, 9 miles double	4	8½	108½ lbs.	Centre and side poles, bracket arm, and span wires	39	—	G.E. 52	3 marine, Brown & Co., Ellis-Eaves induced draught	3 Allis hor. tand cond., 350 h.p
							49	—	G.E. 52	4 marine	2 Cole, Mrchnt. &
							100	—	G.E. 52	5 marine	2 — ...
Southampton	Corporation	7 miles single track	4	8½	86 lbs	Side pole, some centre pole	20	—	Westinghouse	Babcock-Wilcox	Willans .....
Southport	Corporation	3⅔ miles single, 1 mile double	4	8½	87 lbs.	Side poles, bracket arms	15	4	2 25 h.p. per car	Lancashire *	2 Belliss, 330 i.h r.p.m.
South Staffordshire	South Staffordshire Tramways Co.	8 miles	3	6	—	Side trolley (Dickinson)	16	—	15 h.p., E.C.C.	3 Lanc., 30 ft. by 7 ft. ..	3 Musgrave, ho compound con 125 h.p. each
Sunderland	Corporation	13·5 miles single track	4	8½	96 lbs.	Span wire, with rosettes and side poles, and bracket arm	26	—	Dick-Kerr, 2 25 h.p. per car	4 Galloway, 28 ft. by 8 ft. 6 in., economiser	3 Belliss, enclose coupled, 420 h 400 rev. p.m.
Swansea	Swansea Improvements and Tramways Co.	5 miles 39 chains (2 m. 75 c. single, 2 m. 44 c. dbl.)	4	8½	86 lbs.	Bracket and span wire	41	21	Westinghouse and Brush, double motor equipments	Babcock-Wilcox	Ball-Wood .....

BIRMINGHAM.—Accumulator Lines.—Owned by City of Birmingham Tramways Co., Ltd. 3 miles double; gauge, 3 ft. 6 in., 92 lbs. per yard; 10 motor cars; 10 Elwell-Parker motors; chlo mileage, 203,000. Cost per car mile, 13·11d., ratio of expenses to receipts, 82·78.

‡ **LONDON.**—The L.C.C. has voted large sums for electric trolley, surface contact, and underground conduit systems. Adviser, Professor A. B. W. Kennedy. Construction not yet commenced.

ELEC

LONDON.

Baker Street and Waterloo Electric Railway.—Underground tunnels; contractors for line construction, Messrs. Perry & Co.; length 3 miles 1 furlong. To connect Baker Street with Waterloo Station. Stations to provide connection with the Metropolitan Station at Charing Cross and Baker Street, and with the Central London Electric Railway at Oxford Circus, and with the Great Central at Baker Street. Shaft sunk by side of S.E.R. bridge at Charing Cross. Work has been proceeding for about a year, but another three years will elapse before completion. Engineers, Sir Benjamin Baker, Messrs. Galbraith & R. Church.

Central London Railway.—Underground; separate tunnels for "up" and "down" roads; 13 miles track, Shepherd's Bush to Bank; gauge of track, 4 ft. 8½ in.; rails, 100 lbs.; system of working, high tension with 4 transformer substations; working current, 500 volts; 32 locomotives; 170 carriages (7 per train). Power station (Shepherd's Bush) equipment:—16 Babcock-Wilcox water tube boilers, 6 Reynolds-Corliss horizontal compound condensing engines, 6 three-phase alternators (5,000 volts); total capacity, 5,100 kw. Line now nearing completion.

City and South London Electric Railway.—King William Street to Stockwell; twin tunnels, 3½ miles. Gauge of track, 4 ft. 8½ in.; weight of rails, 60 lbs. per yard; 20 electric locomotives. Existing power station contains 8 Lancashire boilers, 28 ft. by 7 ft. 6 in.; 4 400 h.p. vertical engines, with Edison-Hopkinson dynamos, and 1 250 h.p. Willans-Siemens set; total capacity, 1,025 kw. Annual car mileage, 468,500. For the Moorgate Street and Clapham Extensions, the new power station (adjoining old one at Clapham Road) contains 9 economic boilers, 15 ft. by 8 ft. 9 in., 2 horizontal Corliss engines of 1,100 h.p. each, 2 500 h.p., and 2 250 h.p. Willans direct coupled to E.C.C. multipolar generators; total capacity, 2,800 kw. Gauge of track, 4 ft. 8½ in.; rails, 80 lbs. per yard; 32 electric locomotives. Manager, T. C. Jenkins. Electrical engineer, P. V. McMahon.

Great Northern and City Electric Railway.—FINSBURY PARK TO MOORGATE STREET.—Underground tunnels. Messrs. Pearson & Son, Limited, contractors for the construction and equipment. Electric locomotives. Engineers, Sir Douglas Fox and Mr. Francis Fox. Generating station on Regent's Canal. Date of completion, June, 1902.

Metropolitan Underground Railway.—METROPOLITAN AND METROPOLITAN DISTRICT RAILWAY COMPANIES. — *Experimental* electric section, between Earl's Court and High Street, Kensington. Consulting advisers, Sir J. Wolfe Barry

Mather and Platt,
ENGINEERS. LTD.
Electric Railway AND Tramway Plant.
ELECTRIC LIGHTING PLANT.
Electric Transmission AND Distribution of Power.
SALFORD IRON WORKS, MANCHESTER.

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OVERHEAD LINE MATERIAL.
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CIRCUIT BREAKERS FOR RAILWAY WORK.
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bcock-	2 compound	Siemens, compound ..	100	—	—	—	£33,628	Feb., 1892	A. L. Davis	A. L. Davis (assistant)	142,116	—	—	—
ube	Low speed horiz. and high speed, Belliss	E. C. C.....	1,250	£40,000	£73,000	£24,000	£137,000	June, 1898	F. Spade ..	H. F. Street	*	*	*	24 miles new track under construc * Traffic rapidly increasing, exa
y 6 ft.,	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt, E.P.S. battery	120	—	—	—	£33,137	May, '96 and Feb., '99	L. S. Gallaworthy	—	135,740	8·08	71·25%	Lines worked and extensions (2 Electric Tramways Co., Ltd.
8 ft...	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (station), £6,883 (depots),	£17,700	£87,244 *	July, 1899	W. J. McCombe	A. S. Barnard	—	—	—	3½ miles double track now running * Capital outlay figures are to Sep
6 ft...	5 Mather-Platt vertical comp., 90 h.p. each	5 Mather-Platt, 50 kw. each	250	—	—	—	—	July, 1894	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station .....
ft. by	3 Mather-Platt horiz. tandem comp., 180 h.p. each	3 Mather-Platt, 120 kw. each	360	—	—	—	—	Aug., 1898	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....
y 6 ft.	5 Mather-Platt horiz. comp., 120 h.p. each	5 Mather-Platt, 60 kw. each	300	—	—	—	—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....
....	3 Universal, 150 b.h.p. each	6-pole Mordey direct coupled, 100 kw. each	300	—	—	—	—	May, 1898	A. Stewart (Suprtdt.)	J. B. Clarke (Power Suprtdt.)	146,000 (estimated)	—	—	—
8 ft...	Fowler horizontal compound condensing, 2 400 h.p., 1 1,300 h.p.	4 2-pole, 125 kw. each; 1 12-pole, 750 kw.	1,250	—	—	—	—	Aug., 1897	W. Wharam	J. Burbidge	30,000 miles per car	4·83	39%	22 miles track in construction, 30
ft. ..	Willans, 300 and 1,200 h.p.	Siemens	1,200	£67,469	—	£58,492	£125,961	Nov., 1898	C. R. Bellamy	A. B. Holmes	Present daily mileage about 5,000	—	—	Energy purchased from Electric entire city lines are reconstruc the rate of about 1 mile per we
ghing anical	4 750 h.p. cross compound condensing, 90 revs., 2 crank tandem compound	2 cont. cur.; 1 direct coupled, 500 kw., 3-phase 5,000 volts, 2 75 kw. 500 volts for ltg.; 200 kw. rotary convt. and static trans. at sub-station	(Station capacity to be 5,000 h.p.)	—	—	—	—	—	J. C. Robinson, Engineer	H. F. Parshall, Consulting Engineer	—	—	—	About 1 mile of conduit, ¾ in. sl road, 75 miles track, total leng moting, &c.).
	——	——	—	—	—	—	£860,000 voted	—	—	C. H. Wordingham	—	—	—	Power from lighting station .....
ghing	3 400 h.p. Reynolds-Corliss horizontal cross compound condensing engines (Allis)	3 300 kw., 32-pole, 2,500 volt, 3-phase alter., 2 4-pole, 200 kw., rotary conv. and trans. at sub-station	—	—	—	—	—	Aug., 1898	J. C. Robinson, Director and Engineer	—	—	—	—	—
4 300	4 300 h.p. Browett-Lindley compound tandem condensing	4 Westinghouse direct coupled, 200 kw.	800	—	—	—	—	—	A. N. Banister	A. N. Banister	—	—	—	Lines constructing .....
	——	——	—	—	—	—	—	—	J. Aldworth	H. Talbot ..	—	—	—	Arrangements now proceeding for
	——	——	—	—	—	—	—	—	—	—	—	—	—	Drawings and specifications now hands of the Borough Surveyor,
	——	——	—	—	—	—	—	June, 1899	E. H. Mottram (Suprtdt.)	J. A. Fraser (Power (Suprtdt.)	—	—	—	Current obtained from the Ashton-
7 ft.	2 Belliss, 150 h.p., 375 revs.	2 Westinghouse, 6-pole, 100 kw.	200	—	£56,000 *	£7,500	—	Sept., 1899	C. R. Everson	J. H. Rider	Estimated at 150,000	—	—	* Combined lighting and traction p
7 ft.,	2 McIntosh-Seymour, 330 h.p. horiz. tandem comp.	2 G.E., 200 kw., 6 pole, 1 30 kw.	430	—	—	—	—	May, 1899	S. Olver	S. Olver	—	—	—	Capital issued £400,000; electrical miles running.
Babtruc- and	4 Willans, 2 360 h.p. each, 2 200 h.p. each	Mather-Platt, 4-pole; 2 chloride batteries	660	—	£24,000 *	—	—	July, 1899	J. F. Cutler	J. S. Highfield	300,000	—	—	Comb. ltg. and traction statn., pla purposes; plant, track, and over poration; New St. Helens and own cars, paying rent for road a sumed, on sliding scale. * Incl
ft.	8 compound vertical, 100 r.p.m., 1,600 h.p. each	8 compound, 800 kw. each	6,400	—	—	—	—	—	—	C. L. Turner	—	—	—	Lines constructing. Will be opene
Co., uced	3 Allis hor. tand. compd. cond., 350 h.p. each	3 G.E. 225 kw. each ..	675	—	—	—	—	Sept., 1899	H. Mallyon	A. L. C. Fell	—	—	—	Lines running .....
....	2 Cole, Mrchnt. & Morley	2 G.E. 225 kw. each ..	1,000	—	—	—	—	—	—	—	—	—	—	Lines constructing.
....	2 —	2 G.E. 225 kw. each ..	1,000	—	—	—	—	—	—	—	—	—	—	Lines planned.
....	Willans	Crompton	430	—	£10,000	—	—	—	G. B. Carnon	F. H. Chaplin	—	—	—	Constructing. Lighting plant used
....	2 Belliss, 330 i.h.p., 350 r.p.m.	2 Bruce-Peebles, 200 kw.	400	£11,149, rails only	Engines, generators and switchb'd, £6,575	£14,245	£72,575 estimated	—	—	C. D. Taite..	—	—	—	Contracts all placed, but work no * Steam from present lighting stat
ft...	3 Musgrave, horizontal compound condensing, 125 h.p. each	3 E.C.C., 90 kw. each, rope driven	270	—	—	—	—	Jan., 1893	J. J. Robins	J. J. Robins	257,312	7·58	61%	Leased to South Staffordshire Tram
8 ft.	3 Belliss, enclosed direct coupled, 420 h.p. each, 400 rev. p.m.	3 Sunderland Forge, 4-pole compound, 270 kw. each	810	£96,000 (13·5 miles only)	£32,000	Approx. £30,000 (13·5 miles)	£158,000	—	W. Morrison	J. F. C. Snell (also Gen. Manager)	—	—	—	Power to be supplied from extende single track in all to be constru
....	Ball-Wood.....	B.T.H.	400	—	—	—	—	—	D. James ..	H. M. Sayers	—	—	—	Lines nearing completion .....

ll-Parker motors; chloride cells per car, 72 and 96. Station plant:—2 Adamson and 1 Babcock boiler, 3 horizontal non-condensing engines, 160 h.p., 2 Elwell-Parker, belt driven generators; total capacity, 120 kw. Op

not yet commenced.

ECTRIC RAILWAYS.

Corliss engines of
., and 2 250 h.p.
E.C.C. multipolar
2,800 kw. Gauge of
0 lbs. per yard; 32
ager, T. C. Jenkins.
cMahon.

lectric Railway.—
TE STREET.—Under-
rson & Son, Limited,
tion and equipment.
gineers, Sir Douglas
Generating station on
completion, June,

Railway.—METRO-
DISTRICT RAILWAY
electric section,
igh Street, Kensing-
Sir J. Wolfe Barry

and Sir W. H. Preece. The two companies voted £10,000 each to cover cost. Power station plant includes 2 Belliss-Siemens generating sets (practically the same as used at Waterloo and City Railway works), which are expected to form part of permanent equipment when installed. Line stated to be completed. Date of entire equipment depends partly upon the results from working the experimental section.

Waterloo and City Electric Railway.—WATERLOO AND CITY RAILWAY COMPANY, LIMITED.—Twin C.I. tunnels; gauge, 4 ft. 8½ in.; rails, 87⅓ lbs.; 500 volts direct current; third rail between running rails; 12 motor cars; 10 trailers. Power station equipment:—Paxman economic boilers, Belliss enclosed compound engines, Siemens generators; total capacity, 1,200 kw. Total capital outlay (to June 30, 1899), £566,134. Line opened August, 1893. Manager, C. J. Owens. Electrical engineer, W. Heap. Annual mileage, about 100,000 train miles per annum.

PROVINCIAL.

Bessbrook and Newry Tramway. — Three miles double track; gauge, 3 ft.; rails, 41¼ lbs. Operated on third-rail system. Three motor cars; 12 trailers; 1 Mather-Platt 20 h.p. motor per car; chain gear (each motor car hauls 4 trailers). Power station equipped with 1 62 h.p. turbine at 290 revolutions per minute, driving by belt 2 Mather-Platt generators of 18 kw. each, at 1,000 revolutions per minute. Total capital issued, £15,000. Date of opening, October, 1885. Manager, J. Dawson. Engineer, J. L. D. Mears.

Brighton.—VOLK'S ELECTRIC RAILWAY. — Third-rail system; 1 mile track (single) with turn-outs; gauge, 2 ft. 8½ in.; 35 lb. flat bottom rails. Five motor cars; 1 trailer; 1 motor to each car. Electrical equipment:—15 kw. Parker direct current transformer takes current at 230 volts, transformed down to 160 volts; 80 Tudor cells, H. A. 7, 120 ampère hours. Owner and manager of system, Magnus Volk.

Herne Bay Pier Electric Railway.—Owne
the Herne Bay Pier Company, Limited. ¾ m
gauge, 3 ft.; third rail (angle bar beneath de
one car; installation by B.T.H. Co., driver
an 83 b.h.p. Stockport gas engine. Engi
H. C. Dufton.

Liverpool Overhead Electric Railway.
miles double line; gauge, 4 ft. 8½ in.; rails
lbs. Operated on third-rail system; 46 m
cars, 8 trailers, 48 car motors. Power sta
equipment includes 6 boilers, engines, and
erators of 1,500 kw. capacity. A direct dr
800 kw. generator now erecting. Date ope
March 6, 1893. Manager and electrical engi
S. B. Cottrell. Annual car mileage, 750,
Expended on line opened, £629,900; on wor
stock (including generating station), £123,
The company is also constructing a trolley
from Seaforth to Crosby 2½ miles long; ga
4 ft. 8½ in.; rails, 92 lbs.; 8 motor cars an
trailers; 10 car motors. This line is to be worke
means of 2 40 kw. trans. from the rail
generating station, and 2 40 kw. in sub-station

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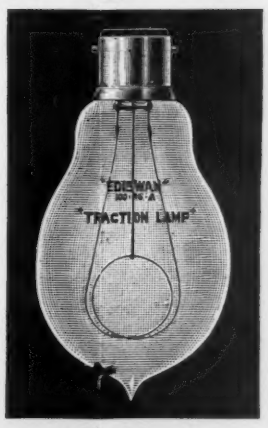

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1900

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4, LUDGATE HILL,

			and 82 lbs.												
.....	3	6	98 lbs.	Side poles	40	—	E.C.C., Westinghouse, B. T. H.	Lanc. and water tube	Low speed horiz. and high speed, Belliss	E. C. C.....	1,250	£40,000	£73,000	£24,000	£137,000
ngle ..	3	6	65 lbs.	Side trolley (Dickinson)	15	—	E.C.C. 1 per car, and others	2 Galloway, 20 ft. by 6 ft., 1 Tinker	3 Willans vertical compound	2 E.C.C., 1 Mather-Platt, E.P.S. battery	120	—	—	—	£33,137
uble, 1 le, central rails	4	8½	96 lbs.	Bracket arm, with centre poles, side poles, and span wire	60	20	Westinghouse and Siemens	4 Lanc., 30 ft. by 8 ft. ..	3 Belliss tandem compound	3 Siemens, 2-pole compound, direct coupled	900	£38,443	£24,218 (station), £6,883 (depots),	£17,700	£87,244 *
s single	3	0	56 lbs.	Bracket arm, centre pole	18	14	2 20 h.p. per car	5 Lanc., 20 ft. by 6 ft...	5 Mather-Platt vertical comp., 90 h.p. each	5 Mather-Platt, 50 kw. each	250	—	—	—	—
s single	3	0	62½ lbs.	Do.	9	9	4 20 h.p. per car	3 Galloway, 26 ft. by 6 ft. 6 ins.	3 Mather-Platt horiz. tandem comp., 180 h.p. each	3 Mather-Platt, 120 kw. each	360	—	—	—	—
s single	3	6	56 lbs. 65 lbs.	Do.	6	—	4 25 h.p. per car	4 Lanc., 26 ft. by 6 ft. 6 ins.	5 Mather-Platt horiz. comp., 120 h.p. each	5 Mather-Platt, 60 kw. each	300	—	—	—	—
.....	3	6	75 lbs.	Bracket arms	9	4	Double motor equipments	3 Babcock-Wilcox	3 Universal, 150 b.h.p. each	6-pole Mordey direct coupled, 100 kw. each	300	—	—	—	—
7 miles	4	8½	100 lbs.	Bracket arm, centre and side poles	75	18	G.E. 800 and G.E. 58	6 Lanc., 30 ft. by 8 ft...	Fowler horizontal compound condensing, 2 400 h.p., 1 1,300 h.p.	4 2-pole, 125 kw. each; 1 12-pole, 750 kw.	1,250	—	—	—	—
.....	4	8½	98 lbs.	Span wires and bracket arms with centre poles	86	15	Schückert, Walker, G.E. 52 and 58, Westinghouse Brush	Lanc., 30 ft. by 8 ft. ..	Willans, 300 and 1,200 h.p.	Siemens	1,200	£67,469	—	£58,492	£125,961
.....	4	8½	—	Double trolley, four overhead wires, three-wire system	—	—	—	8 water tube, weighing hoppers, mechanical stokers	4 750 h.p. cross compound condensing, 90 revs., 2 crank tandem compound	2 cont. cur.; 1 direct coupled, 500 kw., 3-phase 5,000 volts, 2 75 kw. 500 volts for ltg.; 200 kw. rotary convt. and static trans. at sub-station	(Station capacity to be 5,000 h.p.)	—	—	—	—
—	—		—	Span wires (probably)	—	—	—	—	—	—	—	—	—	—	£860,000 voted
.....	3	6	92½ lbs.	Centre and side poles, bracket arm	8 wheel bogie cars	—	G.E. 800	3 water tube, weighing hopper	3 400 h.p. Reynolds-Corliss horizontal cross compound condensing engines (Allis)	3 300 kw., 32-pole, 2,500 volt, 3-phase alter., 2 4-pole, 200 kw., rotary conv. and trans. at sub-station	—	—	—	—	—
single louble	3	6	65 lbs.	Bracket arm and span wire, with side poles and rosettes	40	—	Westinghouse, No. 46A	Babcock-Wilcox, 4 300 h.p.	4 300 h.p. Browett-Lindley compound tandem condensing	4 Westinghouse direct coupled, 200 kw.	800	—	—	—	—
louble, ingle	4	8½	100 lbs.	—	—	—	—	—	—	—	—	—	—	—	—
.....	4	8½	100 lbs.	—	—	—	—	—	—	—	—	—	—	—	—
.....	4	8½	90 lbs.	Span wire	26	12 (on order)	Double motor equipments, G.E. 50	—	—	—	—	—	—	—	—
single 2·7 o be	3	6	92 lbs.	Side brackets and span wires	6	6	Westinghouse, 2 25 h.p.	3 Lanc., 30 ft. by 7 ft. 6 ins.	2 Belliss, 150 h.p., 375 revs.	2 Westinghouse, 6-pole, 100 kw.	200	—	£56,000 *	£7,500	—
.....	4	0	87½ lbs.	Span wire	20	20	G E. 800	3 Lancs, 30 ft. by 7 ft., economiser	2 McIntosh-Seymour, 330 h.p. horiz. tandem comp.	2 G.E., 200 kw., 6 pole, 1 30 kw.	430	—	—	—	—
nning, s con-	4	8½	—	Span wire and side brackets, centre trolley	—	—	G.E. 52	2 Lancashire, 2 Babcock-Wilcox (destructor), superheaters and economisers	4 Willans, 2 360 h.p. each, 2 200 h.p. each	Mather-Platt, 4-pole; 2 chloride batteries	660	—	£24,000 *	—	—
single	4	8½	106 lbs.	Centre poles where possible (otherwise span wires)	150	—	—	16 Lancashire, 30 ft. 9 ft.	8 compound vertical, 100 r.p.m., 1,600 h.p. each	8 compound, 800 kw. each	6,400	—	—	—	—
single, louble	4	8½	108½ lbs.	Centre and side poles, bracket arm, and span wires	39	—	G.E. 52	3 marine, Brown & Co., Ellis-Eaves induced draught	3 Allis hor. tand. compd. cond., 350 h.p. each	3 G.E. 225 kw. each ..	675	—	—	—	—
					49	—	G.E. 52	4 marine	2 Cole, Mrchnt. & Morley	2 G.E. 225 kw. each ..	1,000	—	—	—	—
					100	—	G.E. 52	5 marine	2 —	2 G.E. 225 kw. each ..	1,000	—	—	—	—
single	4	8½	86 lbs	Side pole, some centre pole	20	—	Westinghouse	Babcock-Wilcox	Willans	Crompton	430	—	£10,000	—	—
single, uble	4	8½	87 lbs.	Side poles, bracket arms	15	4	2 25 h.p. per car	Lancashire *	2 Belliss, 330 i.h.p., 350 r.p.m.	2 Bruce-Peebles, 200 kw.	400	£11,149, rails only	Engines, generators and switchb'd, £6,575	£14,245	£72,575 estimated
.....	3	6	—	Side trolley (Dickinson)	16	—	15 h.p., E.C.C.	3 Lanc., 30 ft. by 7 ft. ..	3 Musgrave, horizontal compound condensing, 125 h.p. each	3 E.C.C., 90 kw. each, rope driven	270	—	—	—	—
single	4	8½	96 lbs.	Span wire, with rosettes and side poles, and bracket arm	26	—	Dick-Kerr, 2 25 h.p. per car	4 Galloway, 28 ft. by 8 ft. 6 in., economiser	3 Belliss, enclosed direct coupled, 420 h.p. each, 400 rev. p.m.	3 Sunderland Forge, 4-pole compound, 270 kw. each	810	£96,000 (13·5 miles only)	£32,000	Approx. £30,000 (13·5 miles)	£158,000
chains c. single, c. dbl.)	4	8½	86 lbs.	Bracket and span wire	41	21	Westinghouse and Brush, double motor equipments	Babcock-Wilcox	Ball-Wood	B.T.H.	400	—	—	—	—

ham Tramways Co., Ltd. 3 miles double: gauge, 3 ft 6 in., 92 lbs. per yard; 10 motor cars; 10 Elwell-Parker motors; chloride cells per car, 72 and 96. Station plant:—2 Adamson and 1 Babcock boiler, 3 horizontal n
to receipts, 82·78.
face contact, and underground conduit systems. Adviser, Professor A. B. W. Kennedy. Construction not yet commenced.

ELECTRIC RAILWA

working, high tension with 4 transformer substations; working current, 500 volts: 32 locomotives; 170 carriages (7 per train). Power station (Shepherd's Bush) equipment:—16 Babcock-Wilcox water tube boilers, 6 Reynolds-Corliss horizontal compound condensing engines, 6 three-phase alternators (5,000 volts); total capacity, 5,100 kw. Line now nearing completion.

ity and South London Electric Railway.—King William Street to Stockwell; twin tunnels, 3¼ miles. Gauge of track, 4 ft. 8½ in.; weight of rails, 60 lbs. per yard; 20 electric locomotives. Existing power station contains 8 Lancashire boilers, 28 ft. by 7 ft. 6 in.; 4 400 h.p. vertical engines, with Edison-Hopkinson dynamos, and 1 250 h.p. Willans-Siemens set; total capacity, 1,025 kw. Annual car mileage, 468,500. For the Moorgate Street and Clapham Extensions, the new power station (adjoining old one at Clapham Road) contains 9 economic boilers, 15 ft. by 8 ft. 9 in., 2 horizontal Corliss engines of 1,100 h.p. each, 2 500 h.p., and 2 250 h.p. Willans direct coupled to E.C.C. multipolar generators; total capacity, 2,800 kw. Gauge of track, 4 ft. 8½ in.; rails, 80 lbs. per yard; 32 electric locomotives. Manager, T. C. Jenkins. Electrical engineer, P. V. McMahon.

Great Northern and City Electric Railway.—FINSBURY PARK TO MOORGATE STREET.—Underground tunnels. Messrs. Pearson & Son, Limited, contractors for the construction and equipment. Electric locomotives. Engineers, Sir Douglas Fox and Mr. Francis Fox. Generating station on Regent's Canal. Date of completion, June, 1902.

Metropolitan Underground Railway.—METROPOLITAN AND METROPOLITAN DISTRICT RAILWAY COMPANIES. — *Experimental* electric section, between Earl's Court and High Street, Kensington. Consulting advisers, Sir J. Wolfe Barry and Sir W. H. Preece. The two companies voted £10,000 each to cover cost. Power station plant includes 2 Belliss-Siemens generating sets (practically the same as used at Waterloo and City Railway works), which are expected to form part of permanent equipment when installed. Line stated to be completed. Date of entire equipment depends partly upon the results from working the experimental section.

Waterloo and City Electric Railway.—WATERLOO AND CITY RAILWAY COMPANY, LIMITED.—Twin C.I. tunnels; gauge, 4 ft. 8½ in.; rails, 87½ lbs.; 500 volts direct current; third rail between running rails; 12 motor cars; 10 trailers. Power station equipment:—Paxman economic boilers, Belliss enclosed compound engines, Siemens generators; total capacity, 1,200 kw. Total capital outlay (to June 30, 1899), £566,134. Line opened August, 1898. Manager, C. J. Owens. Electrical engineer, W. Heap. Annual mileage, about 100,000 train miles per annum.

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Bessbrook miles dou Operated cars; 12 t car; chai Power sta 290 revol Mather-P revolution £15,000. Manager,

Brighton.—V rail systen gauge, 2 f motor cars trical equ transform formed do 7, 120 an system, M

MBROIN
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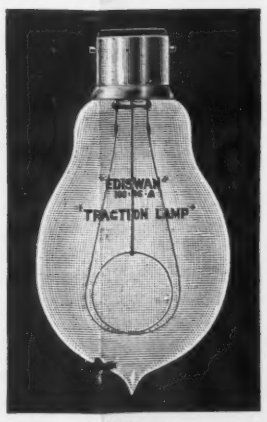

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£24,000	£137,000	June, 1898	F. Spade ..	H. F. Strick	*	*	*	* Traffic rapidly increasing, exact figures cannot be given.	
—	£33,137	May, '96 and Feb., '99	L. S. Gallaworthy	—	135,740	8·08	71·25%	Lines worked and extensions (2¼ miles) owned by Hartlepool Electric Tramways Co., Ltd.	**Hartlepool**
£17,700	£87,244 *	July, 1899	W. J. McCombe	A. S. Barnard	—	—	—	3½ miles double track now running..... * Capital outlay figures are to September 30th, 1899.	**Hull**
—	—	July, 1894	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station	**Isle of Man**—(1) Douglas and Laxey
—	—	Aug., 1898	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....	(2) Laxey and Ramsey
—	—	Aug., 1895	J. Shaw	J. Shaw	—	—	—	1 accumulator sub-station.....	(3) Snaefell Mountain
—	—	May, 1898	A. Stewart (Suprtdt.)	J. B. Clarke (Power Suprtdt.)	146,000 (estimated)	—	—	—	**Kidderminster and Stourport**
—	—	Aug., 1897	W. Wharam	J. Burbidge	30,000 miles per car	4·83	39%	22 miles track in construction, 36 miles projected	**Leeds**
£58,492	£125,961	Nov., 1898	C. R. Bellamy	A. B. Holmes	Present daily mileage about 5,000	—	—	Energy purchased from Electric Lighting Committee. The entire city lines are reconstructing for electrical working at the rate of about 1 mile per week.	**Liverpool**
—	—	—	J. C. Robinson, Engineer	H. F. Parshall, Consulting Engineer	—	—	—	About 1 mile of conduit, ¾ in. slot, centre of track. (39 miles road, 75 miles track, total length of lines constructing, promoting, &c.).	‡ **London** Acton, Shepherd's Bush, Kew, and Hounslow
—	£860,000 voted	—	—	C. H. Wordingham	—	—	—	Power from lighting station	**Manchester**
—	—	Aug., 1898	J. C. Robinson, Director and Engineer	—	—	—	—	—	**Middlesbrough, Stockton, and Thornaby**
—	—	—	A. N. Banister	A. N. Banister	—	—	—	Lines constructing	**Norwich**
—	—	—	J. Aldworth	H. Talbot ..	—	—	—	Arrangements now proceeding for equipment.....	**Nottingham**
—	—	—	—	—	—	—	—	Drawings and specifications now preparing. Arrangements in hands of the Borough Surveyor, Mr. S. A. Pickering.	**Oldham**
—	—	June, 1899	E. H. Mottram (Suprtdt.)	J. A. Fraser (Power (Suprtdt.)	—	—	—	Current obtained from the Ashton-under-Lyne Corporation	**Oldham, Ashton, and Hyde**
£7,500	—	Sept., 1899	C. R. Everson	J. H. Rider	Estimated at 150,000	—	—	* Combined lighting and traction plant	**Plymouth**
—	—	May, 1899	S. Olver	S. Olver	—	—	—	Capital issued £400,000; electrical equipment £57,418. About 8 miles running.	**Potteries (North Staffordshire)**
—	—	July, 1899	J. F. Cutler	J. S. Highfield	300,000	—	—	Comb. ltg. and traction statn., plant used indifferently for both purposes; plant, track, and overhead equip. owned by the Corporation; New St. Helens and Dist. Tram. Co. work lines and own cars, paying rent for road and equip., and for energy consumed, on sliding scale. * Including part of lighting plant	**St. Helens, Lancashire**
—	—	—	—	C. L. Turner	—	—	—	Lines constructing. Will be opened about May, 1900	**Salford**
—	—	Sept., 1899	H. Mallyon	A. L. C. Fell	—	—	—	Lines running	**Sheffield**
—	—	—	—	—	—	—	—	Lines constructing.	
—	—	—	—	—	—	—	—	Lines planned.	
—	—	—	G. B. Carnon	F. H. Chaplin	—	—	—	Constructing. Lighting plant used for power also	**Southampton**
£14,245	£72,575 estimated	—	—	C. D. Taite..	—	—	—	Contracts all placed, but work not yet commenced ..... * Steam from present lighting station.	**Southport**
—	—	Jan., 1893	J. J. Robins	J. J. Robins	257,312	7·58	61%	Leased to South Staffordshire Tramways (Lessee) Co., Ltd.	**South Staffordshire**
Approx. 30,000 5 miles)	£158,000	—	W. Morrison	J. F. C. Snell (also Gen. Manager) -	—	—	—	Power to be supplied from extended lighting station. 23·4 miles single track in all to be constructed.	**Sunderland**
—	—	—	D. James ..	H. M. Sayers	—	—	—	Lines nearing completion	**Swansea**

boiler, 3 horizontal non-condensing engines, 160 h.p., 2 Elwell-Parker, belt driven generators; total capacity, 120 kw. Opened August, 1890. Tramways Manager, F. W. Warren. Annual car

WAYS.

PROVINCIAL.

Bessbrook and Newry Tramway. — Three miles double track; gauge, 3 ft.; rails, 41½ lbs. Operated on third-rail system. Three motor cars; 12 trailers; 1 Mather-Platt 20 h.p. motor per car; chain gear (each motor car hauls 4 trailers). Power station equipped with 1 62 h.p. turbine at 290 revolutions per minute, driving by belt 2 Mather-Platt generators of 18 kw. each, at 1,000 revolutions per minute. Total capital issued, £15,000. Date of opening, October, 1885. Manager, J. Dawson. Engineer, J. L. D. Mears.

Brighton.—Volk's Electric Railway. — Third-rail system; 1 mile track (single) with turn-outs; gauge, 2 ft. 8½ in.; 35 lb. flat bottom rails. Five motor cars; 1 trailer; 1 motor to each car. Electrical equipment:—15 kw. Parker direct current transformer takes current at 230 volts, transformed down to 160 volts; 80 Tudor cells, H. A. 7, 120 ampère hours. Owner and manager of system, Magnus Volk.

Herne Bay Pier Electric Railway.—Owned by the Herne Bay Pier Company, Limited. ¾ mile; gauge, 3 ft.; third rail (angle bar beneath deck); one car; installation by B.T.H. Co., driven by an 83 b.h.p. Stockport gas engine. Engineer, H. C. Dufton.

Liverpool Overhead Electric Railway.—6½ miles double line; gauge, 4 ft. 8½ in.; rails, 56 lbs. Operated on third-rail system; 46 motor cars, 8 trailers, 48 car motors. Power station equipment includes 6 boilers, engines, and generators of 1,500 kw. capacity. A direct driven 800 kw. generator now erecting. Date opened, March 6, 1893. Manager and electrical engineer, S. B. Cottrell. Annual car mileage, 750,000. Expended on line opened, £629,900; on working stock (including generating station), £123,287. The company is also constructing a trolley line from Seaforth to Crosby 2½ miles long; gauge, 4 ft. 8½ in.; rails, 92 lbs.; 8 motor cars and 2 trailers; 10 car motors. This line is to be worked by means of 2 40 kw. trans. from the railway generating station, and 2 40 kw. in sub-station.

Ryde Pier Electric Railway.—Half mile; third rail; gauge, 4 ft. 8½ in.; rails, 30 lbs. Two gas engines drive Siemens generator.

Southend-on-Sea Pier Electric Railway. — Owned by Town Council. Third rail; 1½ miles; gauge, 3 ft.; rails, 40 lbs.; 4 motor cars; 4 trailers. Generating station plant:—2 locomotive boilers, 2 24 h.p. horizontal compound engines, 2 Crompton compound generators; total 20 kw. Opened August, 1891. Electrician, Mr. Norton.

Walton-on-the-Naze Pier Electric Railway.—Owned by the Coast Development Company, Limited. Gauge 3 ft. 6 in.; ordinary Vignoles rails, 36 lbs.; ¼ mile long; channel iron laid between rails on insulators; 2 motor cars; 1 trailer. Generating station plant:—1 semi-portable locomotive boiler, Shanks vertical compound engine, Parker generator, 20 kw. Opened August, 1898. New larger station arranging; car equipment doubling. Consulting engineer, G. L. Addenbrooke.

N

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